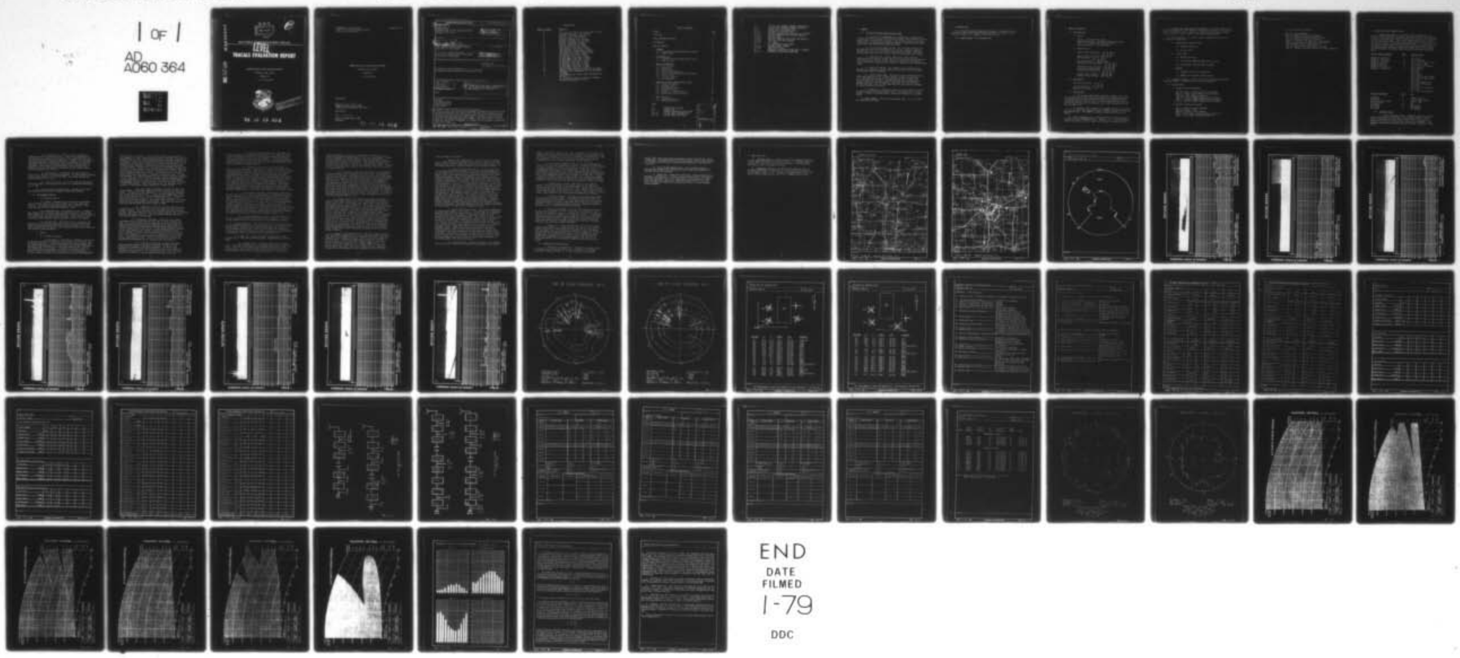
AD-A060 364 FACILITY CHECKING SQUADRON (1866TH) (AFCS) SCOTT AFB IL F/G 17/7
TRACALS EVALUATION REPORT. COMMUNICATIONS STATION EVALUATION RE--ETC(U)
SEP 78 K G MASON
UNCLASSIFIED 78/66C-133 NL

1 OF 1
AD
A060 364



END
DATE
FILMED
1-79
DDC

12

AIR FORCE COMMUNICATIONS SERVICE

LEVEL II

TRACALS EVALUATION REPORT

COMMUNICATIONS STATION EVALUATION REPORT

McConnell AFB, Kansas

78/66C-133

17 - 24 July 1978

DEPARTMENT OF THE AIR FORCE
1866 Facility Checking Squadron (AFCS)
Scott AFB, Illinois 62225

1 September 1978

COMMUNICATIONS STATION EVALUATION REPORT

McConnell AFB, Kansas

78/66C-133

17 - 24 July 1978

Prepared By:

Kenneth G. Mason

KENNETH G. MASON, Major, USAF
Communications Evaluation Team Chief

Approved By:

Cecil C. Robins

CECIL C. ROBINS, Major, USAF
Commander

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER: 14 78/66C-133	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle): COMMUNICATIONS STATION EVALUATION REPORT McConnell AFB, Kansas		5. TYPE OF REPORT & PERIOD COVERED: 9 FINAL Rept., 17-24 July 1978
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s): 10 KENNETH G. MASON, Major, USAF		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS: 1866 Facility Checking Squadron (AFCS) Scott AFB, Illinois 62225		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS: HQ Air Force Communications Service/FFNM Scott AFB, Illinois 62225		12. REPORT DATE: 11 1 September 1978
		13. NUMBER OF PAGES: 61
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)		15. SECURITY CLASS. (of this report): UNCLASSIFIED
		15a. DECLASSIFICATION DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release, distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

Same as report.

12 62p.

6 TRACALS Evaluation Report. Communications Station Evaluation Report, McConnell AFB, Kansas. 17-24 July 1978.

18. SUPPLEMENTARY NOTES

None.

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

TRACALS
ATC Communications
System Evaluation
Rivet Switch

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

A Traffic Control and Landings System (TRACALS) Communications Evaluation was performed at McConnell AFB, Kansas from 17-24 July 1978 to define the capabilities and limitations of the communications system servicing the ground controlled approach radar and control tower. This report can be used as a guide for anticipated performance at McConnell AFB until there is a deletion, addition, relocation of equipment, or a change in horizon profile which would affect the system.

408 827

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

DISTRIBUTION

Number of Copies	Addressee
4	2155 Comm Sq/CC (AFCS), McConnell AFB, KS 67221
2	384 ARW/CC, McConnell AFB, KS 67221
2	SACCA/FF, Offutt AFB, NE 68113
2	SACCA/LG, Offutt AFB, NE 68113
2	SCA/EIEL, Oklahoma City, OK 73145
1	SCA/EIPT, Oklahoma City, OK 73145
2	PCA/EIP, Hickam AFB, HI 96853
1	PCA/EIS, Hickam AFB, HI 96853
10	1866 FCS/CC, Scott AFB, IL 62225
1	1842 EEG/EEIT, Scott AFB, IL 62225
1	1843 EES/EIELT, Hickam AFB, HI 96853
1	1844 EES/EIELT, Griffiss AFB, NY 13441
1	Hq AFCS/OA, Scott AFB, IL 62225
1	Hq AFCS/IGP, Scott AFB, IL 62225
1	Hq AFCS/LGMLE, Scott AFB, IL 62225
2	Hq AFCS/LGMKF, Scott AFB, IL 62225
1	Hq AFCS/FFC, Scott AFB, IL 62225
1	Hq AFCS/FFO, Scott AFB, IL 62225
2	Hq AFCS/FFNM, Scott AFB, IL 62225
1	Hq AFCS/DAPL, Scott AFB, IL 62225
12	DDC-TC, Cameron Station, Alexandria, VA 22314
2	FAA/ARD-5, 800 Independence Ave, SW, Washington, DC 20590
2	FAA/FSNFO/AFS-530, PO Box 25028, Oklahoma City, OK 73125
1	Dr. Jose Perini, Rm 111, Link Hall, Syracuse University, Syracuse, NY 13210

TABLE OF CONTENTS

1. SUMMARY

1-1. Ground/Air/Ground Communications System

a. Ground-to-Air Communications: Ground-to-air communications coverage generally extended well beyond the McConnell AFB air traffic control mission area. Communications coverage at the minimum vectoring altitudes (MVA) within the designated airspace was adequate. Measured receive signal levels were consistently above predicted values.

b. Air-to-Ground Communications: Air-to-ground communications was generally less than the ground-to-air coverage. However, measured receive levels were also consistently above predicted values. Multipath effects were noted, but they were well outside the McConnell AFB airspace.

c. Landline Noise: Several cable pairs of the landlines connecting the GCA and the control tower to the transmitter and the receiver sites had noise as high as -13 dBm. Excessive noise on these landlines could cause serious communications problems if additional cable deterioration occurs.

d. Defective Antennas: One antenna at the transmitter site and two at the receiver site were found to be defective using time domain reflectometer (TDR) measurements.

e. Receive System VSWR: Excessive voltage standing wave ratios (VSWR) were measured on ten of eleven antenna systems at the receiver site. Although the majority of the readings were only slightly over the technical order tolerance, the VSWR readings should be improved by periodic antenna systems maintenance. High VSWRs can, and often do, develop unnoticed, since periodic VSWR checks are not normally performed on receive transmission systems.

f. Coupler Loss: Excessive insertion loss was noted on several of the CU-547/GR antenna multicoupler ports. Insertion loss is critical because it reduces the communications coverage by attenuating the usable signal.

1-2. Power Systems: Both primary and backup power to all facilities was adequate and reliable.

2. RECOMMENDATIONS

2-1. Ground/Air/Ground Communications System: Recommend the anten maintenance team replace those antennas identified as defective, and improve the VSWR on all antennas at the receiver site.

2-2. Power Systems: No recommendations.

3. GENERAL INFORMATION

3-1. Facility Data

a. General

Location: McConnell AFB, Kansas
Communications Area: Strategic Communications Area
Unit: 2155 Communications Squadron (AFCS)
Evaluation Period: 17-24 July 1978

b. Communications

Control Tower Coordinates: 37° 37' 36" N
97° 16' 16" W
Control Tower Elevation: 1360 feet MSL
GCA Coordinates: 37° 37' 18" N
97° 16' 03" W
GCA Site Elevation: 1352 feet MSL
Transmitter Site Coordinates: 37° 36' 36" N
97° 15' 44" W
Transmitter Site Elevation: 1330 feet MSL
Transmitter Antenna Height: 1379 feet MSL
Receiver Site Coordinates: 37° 36' 37" N
97° 15' 09" W
Receiver Site Elevation: 1349 feet MSL
Receiver Antenna Height: 1408 feet MSL

3-2. Runway Data

Airfield Coordinates: 37° 37' N
97° 16' W
Airfield Elevation: 1371 feet MSL
Magnetic Declination: 8° E

3-3. Mission Area

a. The McConnell AFB Control Tower has a control zone within five statute miles of the airport with extensions to seven miles on the 359 radial and to six miles on the 190 radial of the McConnell TACAN. The McConnell Airport Traffic Area is a five statute mile radius of the airport and extends from the surface up to, but not including 3000 feet AGL (see TABs A-1/3).

b. McConnell AFB is under the air traffic control jurisdiction of Wichita Terminal Radar Approach Control (TRACON) located at the Wichita Municipal Airport. The TRACON is allotted airspace from Kansas City Center.

3-4. Mission Responsibility: McConnell AFB has no approach control responsibility or delegated airspace. However, it is a fully operational airport with radar, a control tower, and instrument landing facilities.

3-5. Primary Using Agency/Aircraft Supported: The primary operational user of McConnell AFB is the 384th Air Refueling Wing, flying KC-135 aircraft. Other aircraft which are assigned to, or frequently use the base, include F-105, T-39, UH-1, and all types of Boeing and Cessna aircraft.

3-6. ATC Facilities: Air traffic control equipment at each of the facilities is listed below.

a. Ground Control Approach (GCA)

(1) AN/MPN-13 Radar Set

(2) 302 Key System

b. Control Tower

(1) AN/GSA-135 Console

(2) Four Channel Communications Control System

(3) Bright Radar Indicator Tower Equipment

c. NAVAIDS

(1) AN/GRN-19 Tactical Air Navigation

(2) AN/MRN-7/8 Instrument Landing System

3-7. Logistics Support: Logistics and precision measuring equipment laboratory support is provided by host base organizations.

3-8. Key Personnel

a. Ground Evaluation Personnel

Maj K.G. Mason, Team Chief/Electrical Engineer
MSgt W.V. Rogers, NCOIC TRACALS Evaluation Team
TSgt G.R. Picha, Geodetic Surveyor
SSgt P.A. Tovar, TRACALS Communications Evaluator
SSgt T.P. Barlaan, TRACALS Communications Evaluator
Sgt R.J. Herrera, TRACALS Communications Evaluator

b. Airborne Evaluation Personnel

Maj C.C. Robins, Aircraft Commander
Maj J.R. Barrett, Pilot
SMSgt D.D. Warner, Flight Mechanic
MSgt L.L. Dillingham, Flight Inspection Technician
TSgt E. Long, Flight Inspection Technician

c. Facility Personnel Contacted

Maj G.K. Loud, Commander
Maj F.E. Rodeffer, Chief of Maintenance
Capt D.G. Bates, Maintenance Control Officer
1Lt E.D. Monhemius, Chief ATC Operations
CMSgt J.E. Stockton, ATC Operations Superintendent
MSgt W.D. Boudreaux, ATC Operations Supervisor
MSgt Brightwell, Chief GCA Controller
TSgt J.R. Pardee, Radio Work Center Supervisor
SSgt W.P. Buettner, Assistant Radio Work Center Supervisor

4. GROUND/AIR/GROUND COMMUNICATIONS

4-1. System Description: Air traffic control communications at McConnell AFB are provided by remotely controlled VHF/UHF radio equipment. Landlines interconnect the remote transmitter and receiver facilities with the GCA and control tower. Four channel communications control systems are used to provide keying, amplification, and control of the transmit and receive audio signals to and from the control tower. At the GCA, the 302 Key System provides control for the transmit and receive audio signals. The communications antennas are mounted on wooden poles, 40 to 50 feet above the ground. Each control facility has its own backup radio equipment.

VHF/UHF RADIO EQUIPMENT	QNTY	FREQ (MHz) USE
AN/GRT-18 Transmitter	1	119.5 ATIS
AN/GRT-21 Transmitter	3	121.5 Emergency
AN/GRT-22 Transmitter	16	126.2 Control Tower Primary
AN/GRR-24 Receiver	15	236.6 Control Tower
AN/GRR-25 Receiver	3	239.8 Pilot-to-Forecaster
AN/GRC-171 Transceiver	1	243.0 Emergency
AN/GRC-175 Transceiver	1	266.2 Rescue
		269.1 GCA
		269.9 ATIS
		271.9 Rescue
		275.8 Control Tower Ground
		295.7 Control Tower Primary
		302.2 GCA
		311.0 Wing Command Post
		321.0 Wing Command Post
		339.3 GCA
		342.5 Pilot-to-Forecaster
		351.1 GCA
		372.2 Pilot-to-Dispatcher

ANCILLARY EQUIPMENT	QNTY	USE
CU-547/GR	6	Antenna Coupler
AN/GSA-135	1	Control Tower Console
Four Channel Key System	1	Control Tower
302 Key System	1	GCA
AT-197/GR	26	UHF Antenna
AS-1097/GR	4	UHF Antenna
AS-1181/UR	7	VHF Antenna

4-2. Equipment Status

a. Facility Equipment Status: Equipment checks were accomplished using procedures described in the equipment technical orders. Where no procedures are given, AFCSP 100-61, Vol XIII was used as a guideline to ascertain the operational status of the equipment. The equipment specifications and test results are shown in TABs E-1-1 thru E-5-2.

(1) Transmitter Site: Three of the six transmitters checked had incorrect modulation levels. One of the transmitters was clipping severely causing high distortion. This conditions could not be corrected to specifications by adjustment. However, local maintenance personnel repaired the transmitter prior to the departure of the team. One other transmitter also had high distortion which was corrected by adjustment. One antenna at the transmitter site was identified as defective using the time domain reflectometer and one antenna coupler had high insertion loss (3.8 dB).

(2) Receiver Site: Two receivers had poor signal-to-noise ratios. One was corrected by adjustment. Ten of the eleven antennas checked at the receiver site had high VSWR. One antenna coupler had high insertion loss (3.1 dB).

(3) Control Facilities: All of the landlines checked had high noise levels. The average noise level was -24 dBm while the highest was -13 dBm.

b. Supporting Test Equipment Status: Adequate and reliable test equipment was available to squadron maintenance personnel.

4-3. Environmental Factors

a. Siting Characteristics

(1) General: McConnell AFB is located on the southeast side of Wichita, Kansas in the south central part of the state (see TAB A-1). The terrain surrounding the base in all quadrants is flat grasslands and tillable fields with patches of trees.

(2) Transmitter Site: The transmitter site is located on the southeast side of the base about one-half mile east of the approach end of runway 36. The terrain surrounding the transmitter site is generally flat rolling grasslands with patches of trees. Trees to the east and structures to the northwest create screening as high as +0.5 degrees.

(3) Receiver Site: The receiver site is located on the southeast side of the base approximately one mile east of the approach-end of runway 36 and one-half mile east of the transmitter site. The terrain surrounding the receiver site is similar to that at the transmitter site with very little screening.

b. Weather

(1) Surface Climatology

(a) McConnell Air Force Base is located on flat terrain in the South Central Plains about half way between the Mississippi River and the Rocky Mountains. The elevation across this region changes from a few hundred feet above sea level at the Mississippi to about 6,000 feet at the eastern edge of the Rockies. The station elevation of 1,371 feet falls between these two extremes. The nearest large body of water is the Gulf of Mexico located about 500 miles to the south-southeast. It is the major source of moisture for the McConnell area since the predominant

wind direction is southerly. The Great Lakes region, about 600 miles to the northest, is a less important moisture source and affects the area only when the winds are from a north through northeast direction for periods of 12-24 hours. Due to the flat terrain and lack of sufficient moisture, the ingredients for convective activity must be advected to McConnell. Once formed, activity movement is governed by the upper wind with no effect from the terrain. McConnell is in a transition zone between the semi-arid or steppe climate of western Kansas and the humid micro-thermal climate of eastern Kansas and Missouri. The local climate supports typical grass and grain vegetation common to the Plains. The Arkansas River is the major stream in the local area and is a tributary of the Mississippi. It flows from northwest to southeast through the city of Wichita and passes McConnell 3 miles to the west. Winds from the northwest through northeast create a slight downslope effect, while wind from the east-south-east through south-southwest creates a slight upslope. Wind flow from other directions is essentially neutral. These local effects are very important in the formation or nonformation and/or advection of stratus and fog.

(b) The climate of McConnell is characterized by the marked changes in temperature common to interior locations of large land masses. In January the mean temperature is 31°F with the mean maximum of 40°F and the mean minimum of 21°F. In July the mean temperature is 80°F with the mean maximum of 91°F and the mean minimum of 70°F. The average annual precipitation in this area is 32 inches with June, July, and August being the wettest months. The average annual snowfall is 15 inches occurring mainly from November through March. The prevailing winds are from the south throughout the year at about 10 knots.

(c) Conditions of ceilings less than 3000 feet and or visibilities less than 3 miles vary from 5% in August to almost 25% from December to March. Poor conditions are distributed uniformly throughout the day. The winter months also have the highest frequency (4%) of conditions below 200 feet and/or 1/2 mile. The hours between 0600 and 0800 local time have the poorest flying weather.

(2) Propagation Climatology: During the winter months continental polar (cP) and maritime polar (mP) air masses dominate the area. Early in the season, prior to snow cover, the cP air tends to be moderately subrefractive during the afternoons due to heating near the surface, while at night propagation conditions become standard and then slightly superrefractive near sunrise. As the season progresses and more of the surface becomes snow covered, propagation conditions become mainly standard to slightly subrefractive with small diurnal variations. The initial outbreak of cP air is usually accompanied by strong surface winds. The turbulence associated with the winds tend to wipe out the surface superrefractive layer. The mP air arriving over the area has been modified considerably by its trajectory over the mountains.

(a) In the early spring the air masses are about equally divided between cP and mP with maritime tropical (mT) air becoming more frequent as the season progresses. In the fall the dominant air mass is mP with some diminishing mT and a few isolated cP outbreaks late in the season. During those two seasons the refractive profiles are standard to slightly subrefractive most of the time.

(b) During the summer the area will experience the maximum occurrence of superrefractive conditions. The summer air masses in this region consist mainly of mT and dry mP with some incursions of continental tropical (cT) air from the southwest. As mT air has moved overland it has dried in the lower levels because of extensive convective mixing of the moist surface air and the drier air aloft causing the lower levels to become less superrefractive.

(c) Nighttime cooling causes the lower levels to become more superrefractive. Occasionally on nights of clear skies and calm winds ducts of trapping intensity form. These ducts tend to dissipate rapidly with daytime heating. When mT air over the area is associated with thunderstorm activity, the lower levels become more moist than normal because rain falls out of the air mass and evaporates into these levels. A superrefractive stratum sufficiently intense to cause trapping even during the day is not uncommon. During the occasions that cT air is in the area, the profile is strongly subrefractive to high levels; with nighttime cooling the profile becomes near standard. Upper level subsidence associated with high pressure systems will create a superrefractive elevated layer. During winter the rather rapid transition of migratory systems prevents such layers from becoming a significant problem.

(d) The chart "Frequency of Refractive Conditions in Percent" (see TAB G-1) is derived from summaries of atmospheric refractive indexes prepared by the USAF Environmental Techncial Applications Center (AWS). It was computed for the nearest rawinsonde station considered to be representative of this site. The chart represents a count by month, over the period of record of three or more years, of the minimum gradient category in percent frequency of occurrence. Only the one minimum gradient category in each upper air sounding has been counted. For this reason subrefraction is seldom shown on the chart, as more negative gradients will usually be found and counted. A discussion of refractive theory, and a description of the refractive index categories and their corresponding gradients in N-units per 1000 feet are found in TABs B-2-1/2.

(3) Evaluation Weather Conditions: Normal refractive conditions occurred during the flying phase of the evaluation. These conditions allowed for radio signal propagation along theoretical limits.

4-4. Evaluation Profile: The overall objectives of the evaluation were to define the capabilities and limitations of the air traffic control communications equipment in the installed environment and to optimize the performance of the system. These objectives were met by making the siting and environmental studies discussed in paragraph 4-3 and performing the equipment, system, and airborne checks described below.

a. Ground Tests: Ground test were performed prior to the airborne tests. They consisted of two types: equipment checks and loop tests.

(1) Equipment Checks: Equipment checks were performed prior to loop and airborne tests to ensure proper operation of major end items. The results of the checks were compared with technical order specifications. Where technical order specifications were not listed, the data base built from prior evaluations was used as a reference in

determining equipment performance. Additional information, such as antenna placement measurements (TABs D-1-1/2) was also obtained. Adjustments of equipment for optimum operation were made immediately, if possible without extensive maintenance. Other problems were identified to maintenance personnel for correction. The corrected readings are included in the "adjusted" column of the equipment check forms. The audio amplifier measurements were recorded after the amplifiers were adjusted for normal operation.

(2) Loop Tests: Loop tests were utilized to evaluate the system performance of the previously tested end items. An operational position in the GCA and a maintenance position in the control tower were used for the loop tests. A one kHz tone was injected into the microphone amplifiers for simulation of a normal voice input. One frequency at a time was keyed. The signal levels, signal-to-noise, and modulation measurements were taken on the transmit portion of the system with a dummy load placed on the transmitter. The one kHz tone was removed and noise and carrier power measurements were taken. The audio measurements were taken on the receiver side of the system using a 30 percent modulated RF carrier connected to the input of the receiver equipment. The audio measurements were taken at accessible points in the system. The resulting data were used to determine the signal levels presented on the Loop Test Line Level Diagrams (TABs E-5-1/2).

b. Airborne Tests: The airborne tests were accomplished using a C-140A flight inspection aircraft flying radials and orbits off the McConnell TACAN. The automatic gain control (AGC) current of the airborne receiver was used to obtain the receive signal level (RSL) of the communications frequency under test. Ten radial tracks and one orbit were flown using the aircraft receiver to measure the ground-to-air transmit signal strength; four radial tracks and one orbit were flown using a ground receiver to measure air-to-ground transmit signal strength (see TAB F-1). Radial track measurements were used to determine vertical radiation patterns, and orbital tracks were used to determine horizontal coverage. Prior to the airborne tests, the aircraft and ground receiver AGC currents were calibrated in dBm by injecting known signal levels into the receiver's RF transmission line and annotating the strip chart recordings. The ground transmitter was continuously keyed with the output power set at 10 watts. The aircraft transmitter output was measured and recorded. While measuring the air-to-ground signal strength the aircraft transmitter was keyed on and off at ten seconds intervals.

4-5. Analysis of Evaluations Results: AFM 55-8 tolerances specify clear and readable communications at an altitude which meets operational requirements at a minimum distance of 15 NM for the control tower and 30 NM for the GCA. Emergency communications is desired to extend as far as possible. Pilot-to-Forecaster communications is required to 100 NM at 20,000 feet above the site elevation (AWSR 105-12). The receive signal level flight profile is shown in TAB F-1. The data from the orbits and radial tracks give a composite three dimensional picture of the electromagnetic radiation patterns of the air traffic

control antennas at McConnell.

a. Ground-to-Air Communications: The results of the ground-to-air signal strength measurements are in TABs F-2-1 and F-3-1/3. One orbit and several radial tracks were flown to collect data to depict the horizontal and vertical radiation patterns of the transmit antennas.

(1) Horizontal Radiation Pattern: The orbits were flown at the higher operational altitudes and at a radius which encompassed the air traffic control mission area. Therefore, the flight data gives a good picture of the communications coverage of the McConnell air traffic control environment. Due to the uniformity of the terrain, and the heights of the antenna towers, the measured signal levels were relatively constant throughout most of the orbit. The first half of the orbit had a average signal level of -73.33 dBm, while the second half of the orbit had an average of -74.20 dBm. All measurements throughout the orbit were well within the -93 dBm squelch threshold setting for which most aircraft receivers are set, and most were within the calculated theoretical free space signal strength value of -79.25 dBm. One of the higher frequencies was used for the test because it shows the worst case propagation characteristics. The higher frequencies are more subject to path loss and other environmental factors. The formula used for calculating the predicted free space values takes into account frequency, transmitted power, cable loss, antenna gain and theoretical path loss. Screening, multipath effects, and weather conditions are not considered in the formula. However, screening and weather effects were negligible factors during the evaluation. Multipath propagation effects probably contributed to the variances in signal levels throughout the orbit.

(2) Vertical Radiation Pattern: The AT-197/GR antenna was the predominant antenna at this location. This antenna has a much better radiation pattern for air traffic control purposes than the AS-1097/GR. The gain of the AT-197/GR antenna is relatively constant for most operational air traffic control altitudes. This antenna is ideally suited for the low altitude ATC environment at McConnell, since it has excellent gain at low altitudes. The radiation patterns shown in TABs F-3-1/3 depict solid coverage throughout the ATC mission area with minor nulls at high altitudes at long ranges from the station. As explained in paragraph 4-5a(1), these nulls were most likely formed because of multipath effects. These effects were more evident in the receive radiation patterns (TABs F-3-4/6) because the receiver site was more susceptible to multipath reception at the altitudes and azimuths shown in the TABs. Note that all the nulls are well outside of the air traffic control mission area. Minor antenna or transmission line defects could have also played a minor role in the less than optimum performance at the extreme edges of the radiation patterns.

(3) Screening Effects: Due to the heights of the antennas and the relatively flat terrain surrounding the transmitter and receiver

sites, significant screening effects were not evident in the orbital data. However, the skyline graphs do show some screening at the transmitter site from 066 to 110 degrees and from 290 to 318 degrees (see TABs C-1/2). TABs B-1-1/4 and B-2-1/4 show the surrounding terrain and give a graphical representation of the screening environment at both locations.

b. Air-to-Ground Communications: Air-to-ground coverage was generally less than the ground-to-air coverage. As much as 10 dB difference in signal strength was noted at selected points around the orbits. This difference was mainly due to the exceptionally strong signal strenth measurements of the ground-to-air signal. However, the data shows that the air-to-ground coverage also generally extended well beyond the mission area. Radial data showed coverage to at least 50 NM at 3500 feet MSL. A sample of the air-to-ground coverage is shown in TAB F-2-2. Better than normal coverage was due to the excellent propagation conditions during the flight portion of the evaluation and the good siting conditions at both locations.

c. Landline Noise: Several cable pairs on the commercial landlines connecting the GCA and the control tower to the transmitter and the receiver sites had excessive noise levels. Noise levels as high as -13 dBm were measured on some of the pairs. Past TRACALS evaluation data suggest that the noise level should be at least -35 dBm or lower. Excessive noise in these landlines could cause serious communications problems.

d. Defective Antennas: Time domain reflectometer measurements were made on all antenna systems. One antenna at the transmitter site and two antennas at the receiver site were found defective. This finding agreed with results of previous TDR graphs made by the local maintenance personnel. Since an antenna maintenance team was scheduled to return in the near future, no additional actions were taken.

e. Receive System VSWR: Excessive VSWR readings were measured on ten of eleven antennas at the receiver site. The majority of the readings were between 2:1 and 3:1. Although this range is not excessively high, it is outside the technical order tolerance of 1.6:1. The antenna maintenance team could improve these readings by cleaning the connectors and/or replacing the cables. VSWR checks on the receive transmission systems are normally not frequently accomplished; therefore, high VSWR conditions can, and often, develop unnoticed.

f. Coupler Loss: Excessive insertion loss in the CU-547/GR antenna multi-couplers is a common problem. The insertion loss specification in Table II, TO 31R1-2GR-142 is a maximum of 2 dB. The coupler with the highest loss at the transmitter site had a reading of 3.8 dB. At the receiver site, the greatest loss was 3.1 dB. Although the cause of the high loss is basically in the design of the tuning cavity of the coupler, the maintenance unit can usually minimize the loss by fine tuning the coupler, or by rearranging frequencies associated with each coupler.

4-6. Capabilities and Limitations

a. Ground-to-Air Communications: Ground-to-air communications is adequate for the McConnell AFB mission. Coverage at the minimum vectoring altitudes (see TAB A-3) is solid throughout all quadrants.

Strong signal levels were measured throughout and well outside the required mission area. Screening effects are not significant; line of sight coverage is limited by the curvature of the earth and attenuation of the signal by free space.

b. Air-to-Ground Communications: Air-to-ground coverage is less than the ground-to-air coverage, but much greater than required for adequate mission area coverage.

c. Predictions: Under normal conditions, adequate communications coverage of the McConnell air traffic control mission area can be expected. Occasional multipath fading is possible because of the presence of large flat areas adjacent to the sites. Additional deterioration in the land-lines, antennas and transmission systems could result in serious communications problems.

5. POWER FACILITIES

5-1. Equipment Details: Commerical power is provided for the GCA, control tower, transmitter site, and receiver site. Secondary power is provided for at each facility by backup generators. No deficiencies were noted at any of the power facilities.

5-2. Adequacy/Reliability: The backup power generators were in outstanding condition. A detailed list of the equipment test results are presented in TABs E-6-1/4. Primary and secondary power for all air traffic control communications facilities is adequate and reliable.

TITLE:

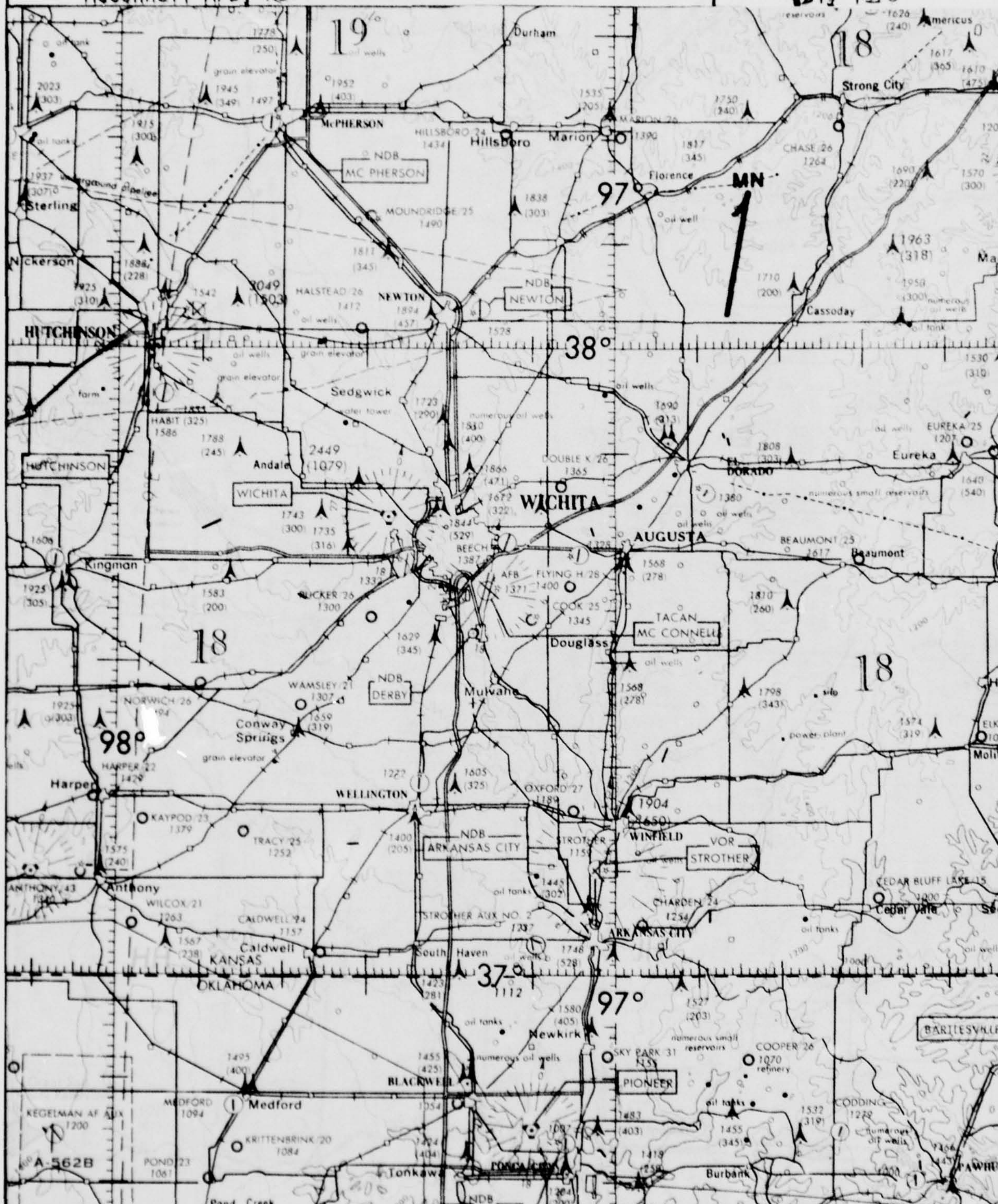
GEOGRAPHIC LOCATION

LOCATION

McConnell AFB, KS

DATE

July 1978



REMARKS

Scale: 1:1,000,000 Magnetic Declination: 8° E

AFCS FORM MAY 73 906 GENERAL INFORMATION TAB: A-1

TITLE

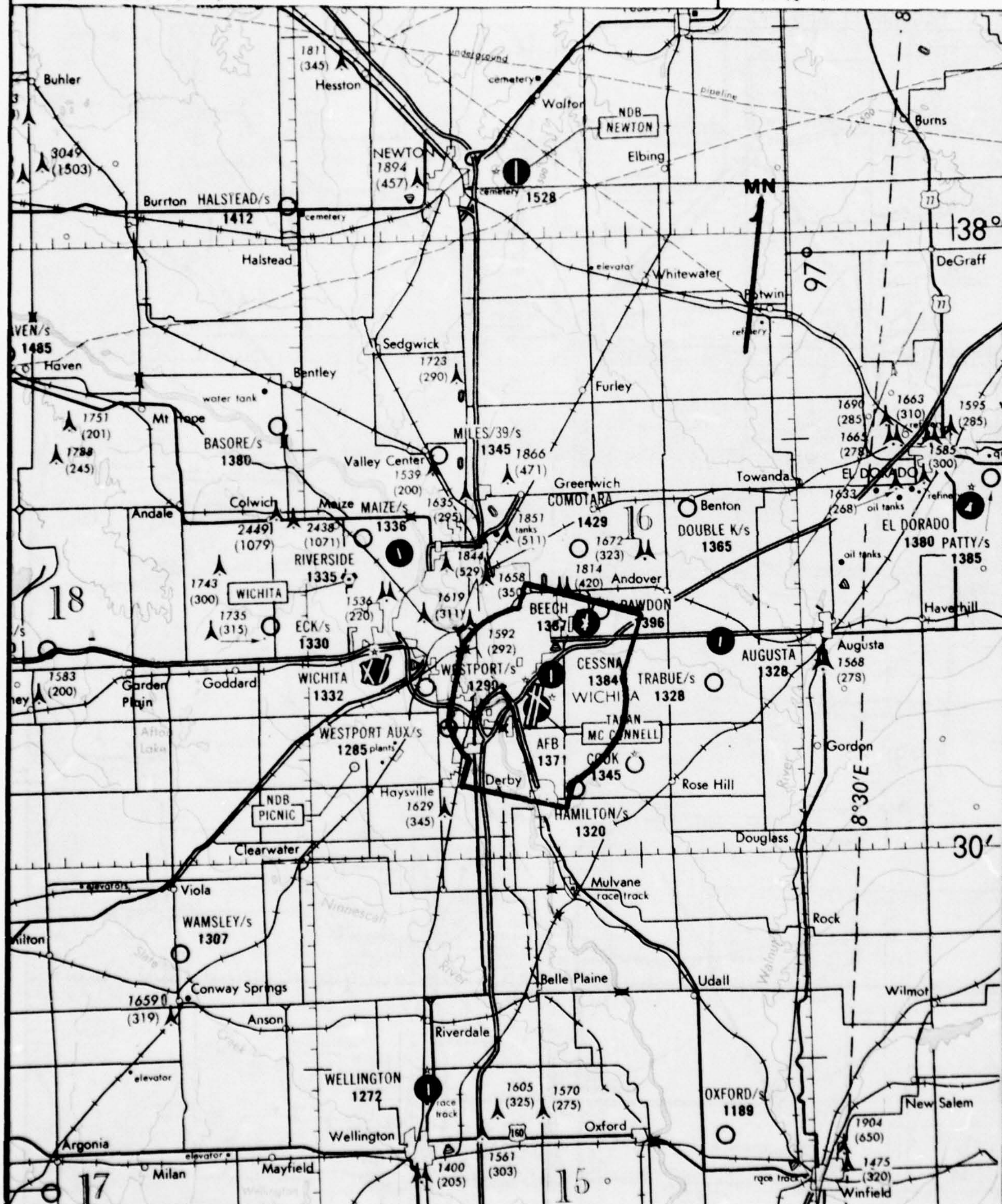
CONTROL ZONE

LOCATION

McConnell AFB, KS

DATE

July 1978



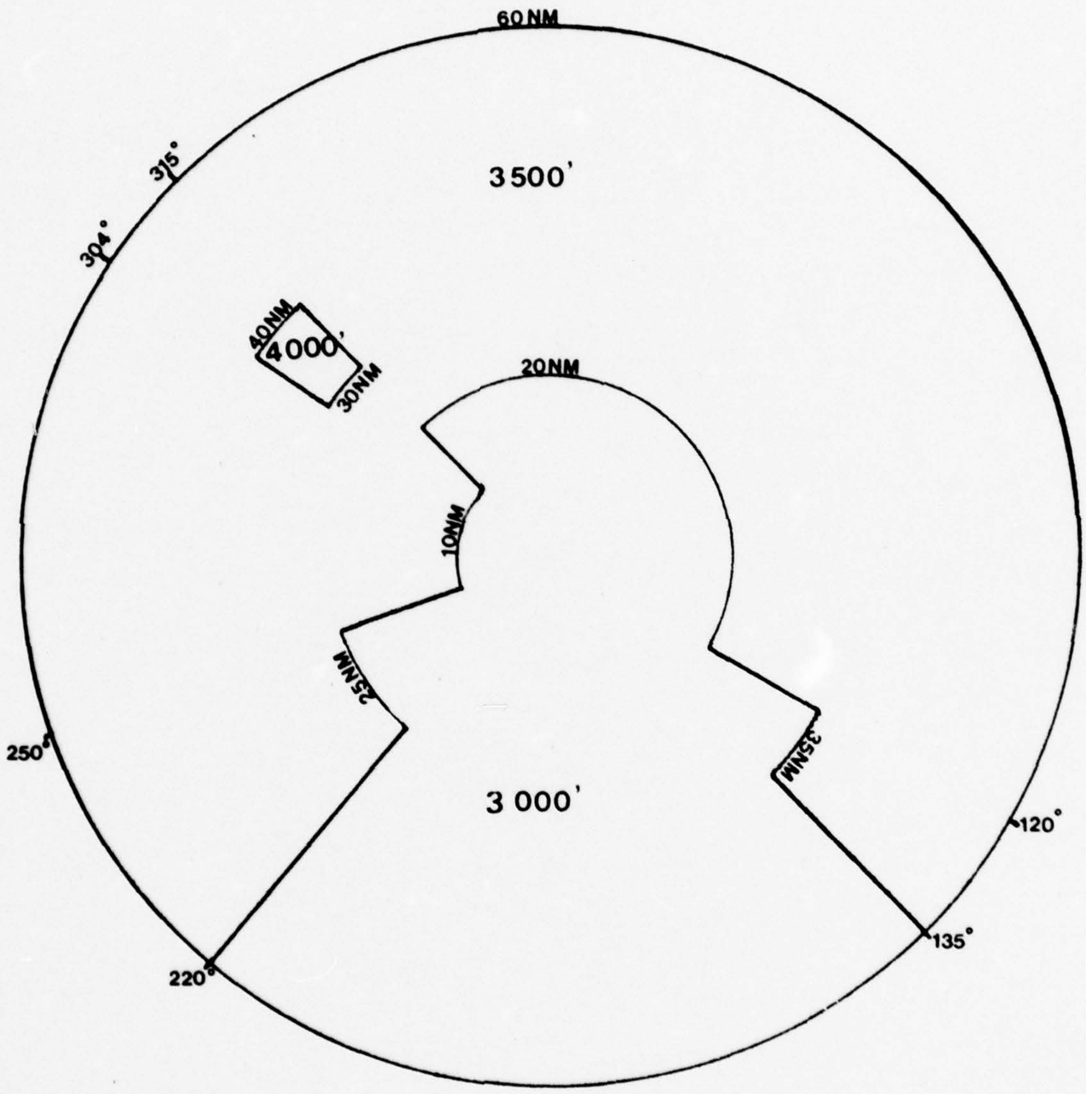
REMARKS

Scale: 1:500,000 Magnetic Declination: 8° E

TITLE:

MINIMUM VECTORING ALTITUDE CHART

LOCATION	DATE
McConnell AFB, KS	July 1978

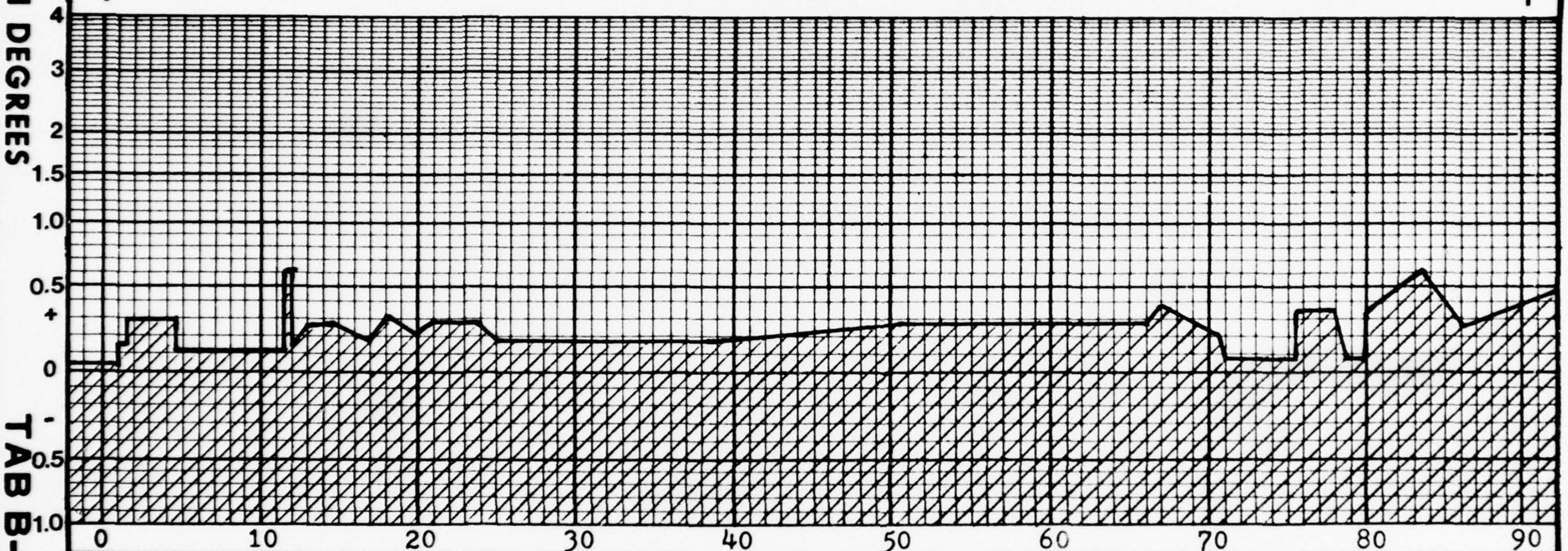


REMARKS

SKYLINE GRAPH

0.2-3

DISTANCE TO FAR HORIZON IN NAUTICAL MILES.



ORIENTED TO: MAGNETIC NORTH

MAGNETIC DECLINATION: 8° E

AFCS FORM MAY 73 913

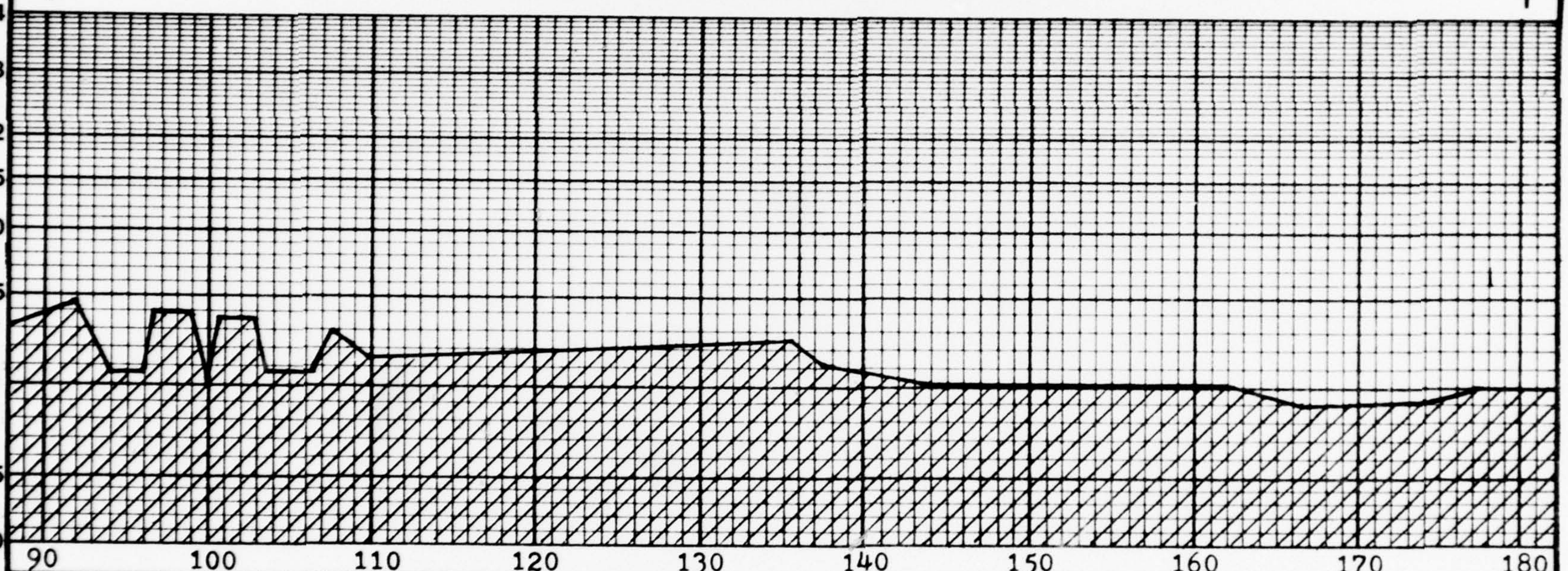
STATION McCONNELL AFB, KS

EQUIPMENT TRANSMITTERS

SKYLINE GRAPH

0.4-4

DISTANCE TO FAR HORIZON IN NAUTICAL MILES.



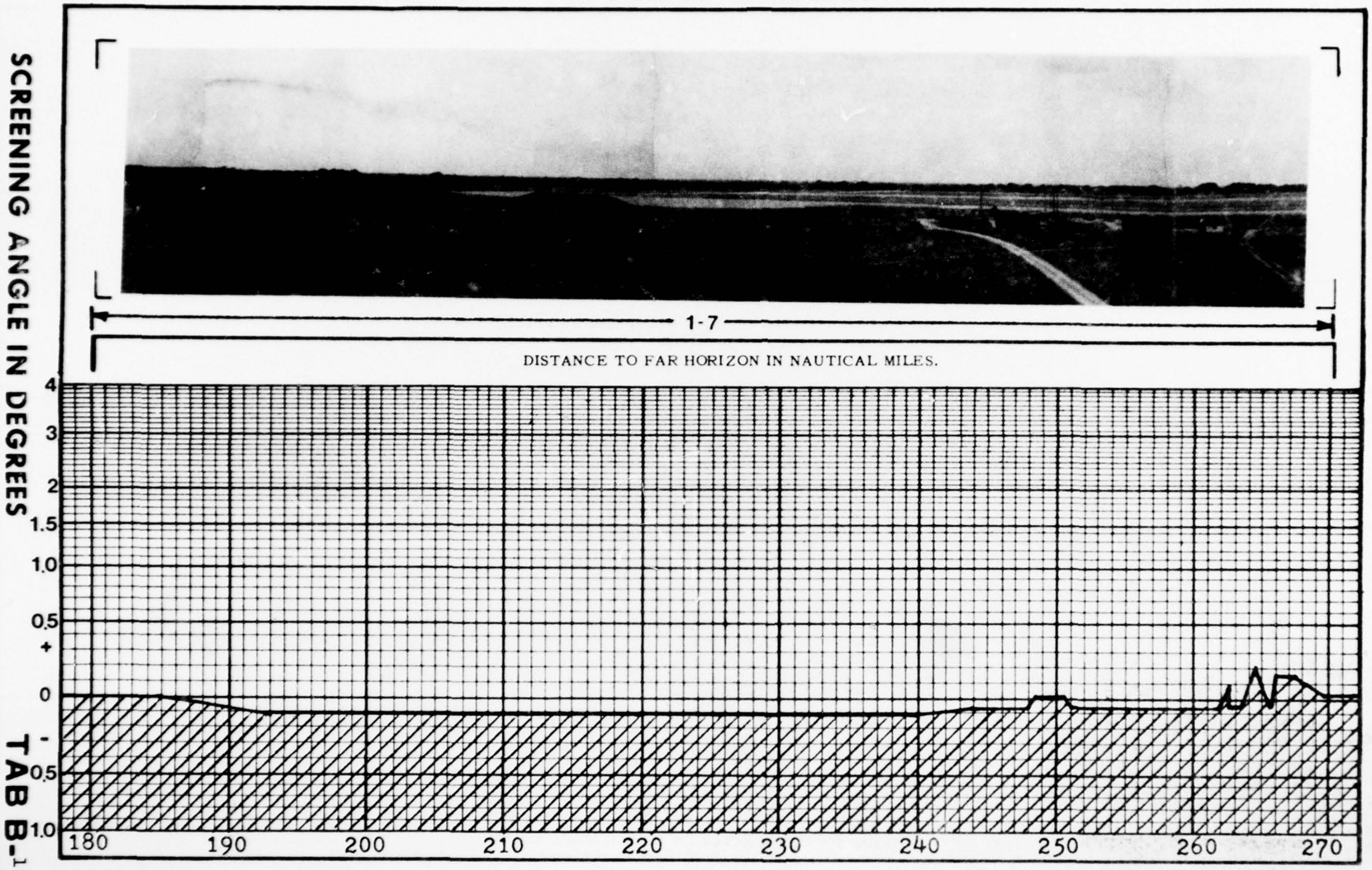
ORIENTED TO: MAGNETIC NORTH

AFCS FORM MAY 73 913 MAGNETIC DECLINATION: 8° E

STATION McCONNELL AFB, KS

EQUIPMENT TRANSMITTERS

SKYLINE GRAPH



ORIENTED TO: MAGNETIC NORTH

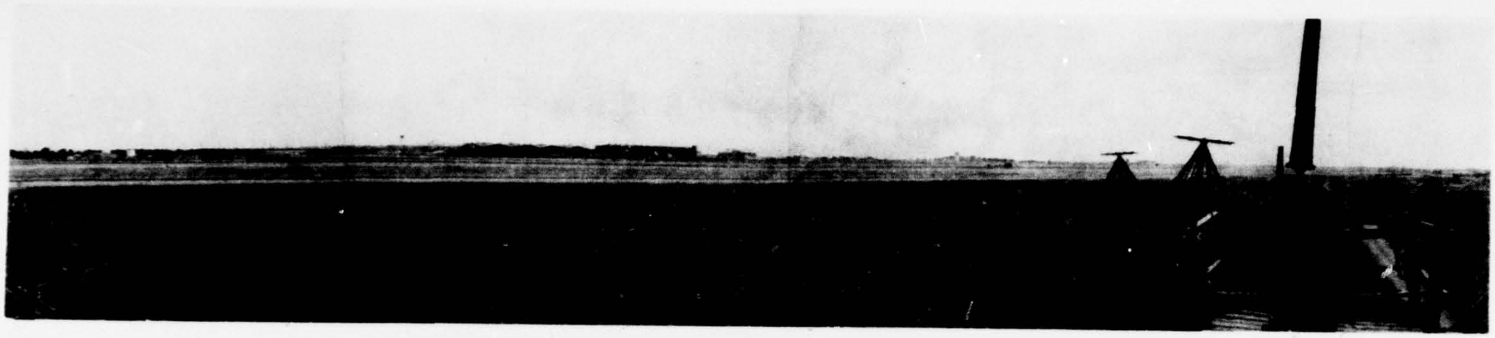
MAGNETIC DECLINATION: 8° E

STATION McCONNELL AFB, KS

EQUIPMENT TRANSMITTERS

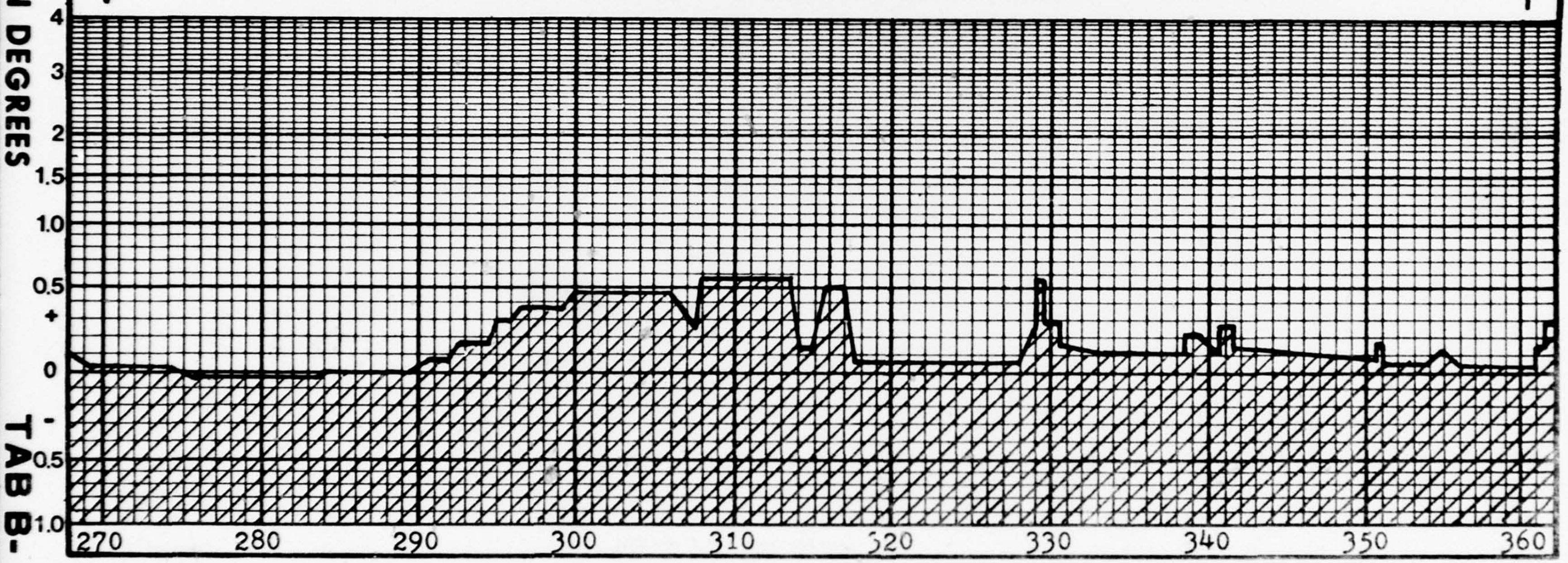
AFCS FORM MAY 73 913

SKYLINE GRAPH



1-5

DISTANCE TO FAR HORIZON IN NAUTICAL MILES.



ORIENTED TO: MAGNETIC NORTH

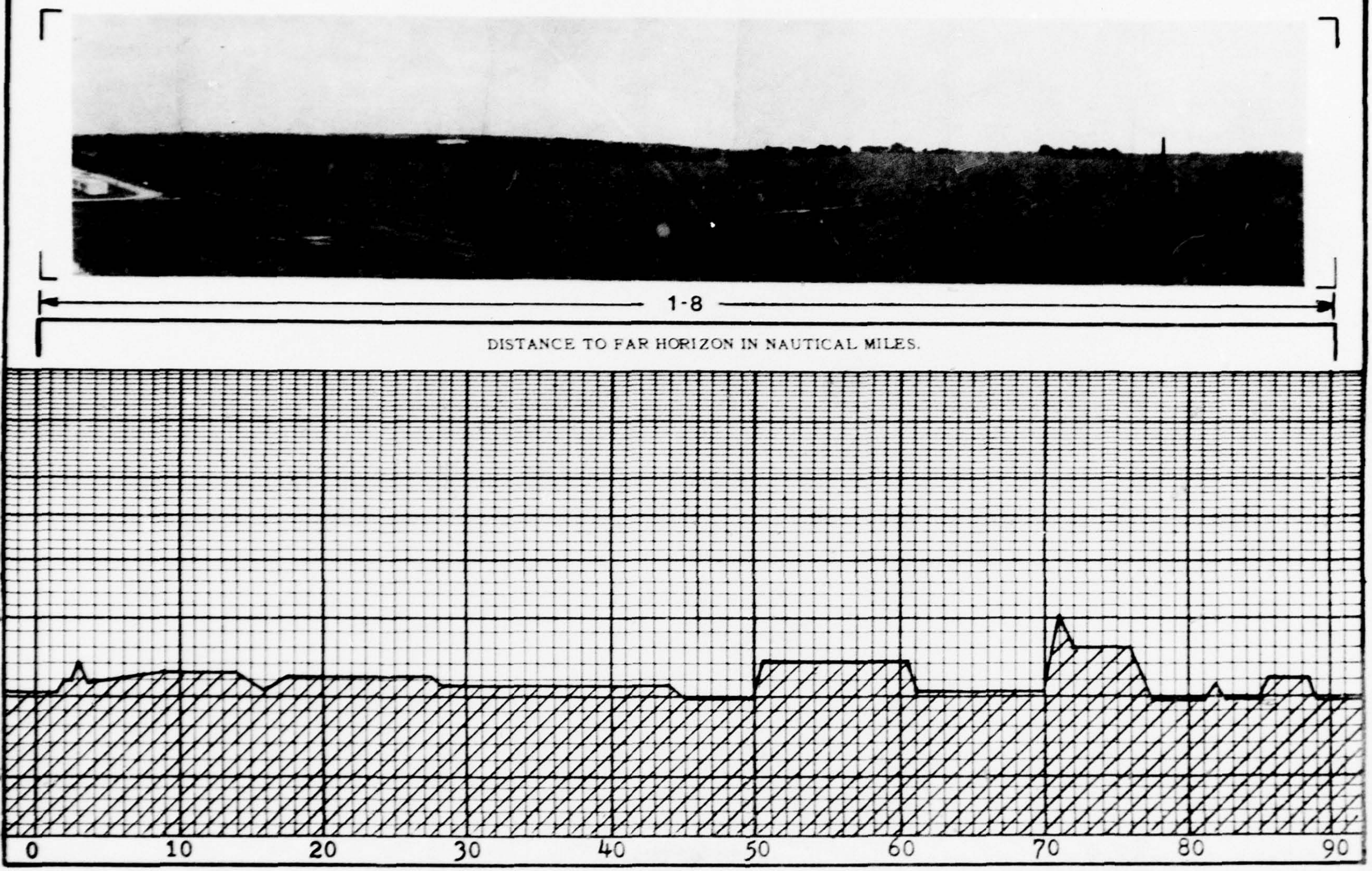
MAGNETIC DECLINATION: 8° E

STATION McCONNELL AFB, KS

EQUIPMENT TRANSMITTERS

AFCS FORM MAY 73 913

SKYLINE GRAPH



ORIENTED TO: MAGNETIC NORTH

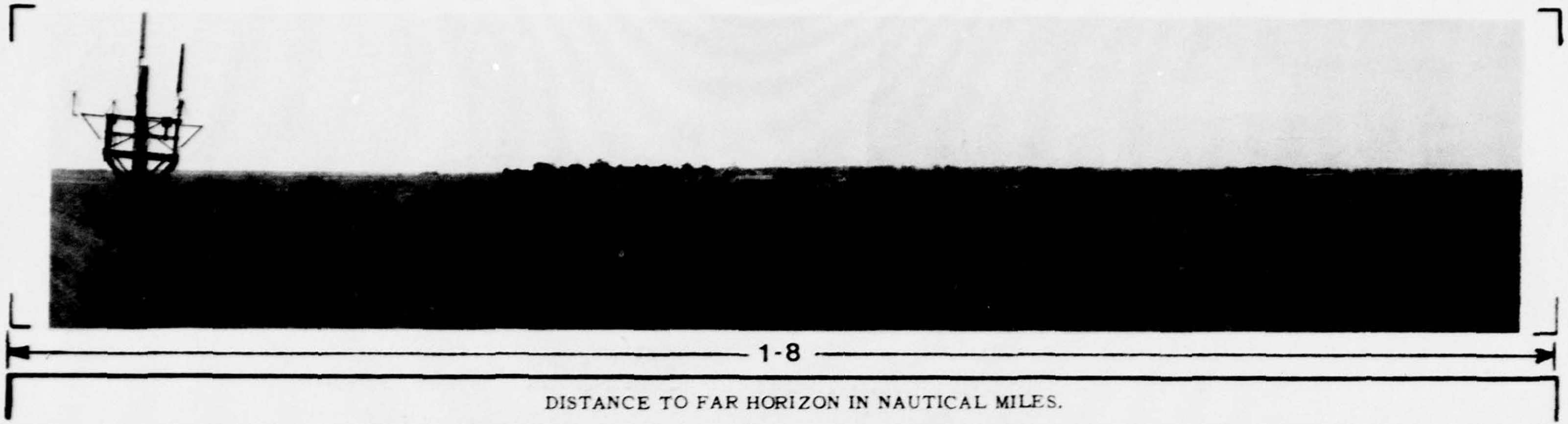
MAGNETIC DECLINATION: 8° E

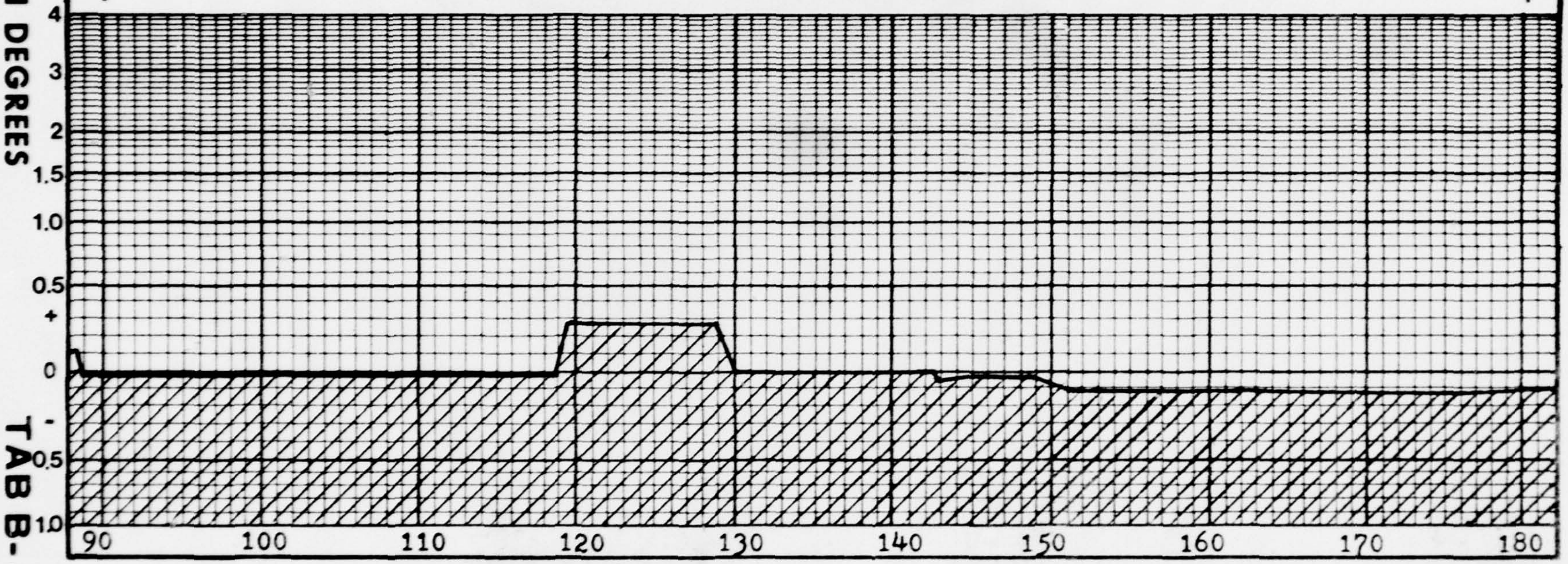
AFCS FORM 913

STATION McCONNELL AFB, KS

EQUIPMENT RECEIVERS

SKYLINE GRAPH





ORIENTED TO: MAGNETIC NORTH

MAGNETIC DECLINATION: 8° E

STATION McCONNELL AFB, KS

EQUIPMENT RECEIVERS

AFCS FORM 913

TAB B- 2-2

SKYLINE GRAPH

ORIENTED TO: MAGNETIC NORTH

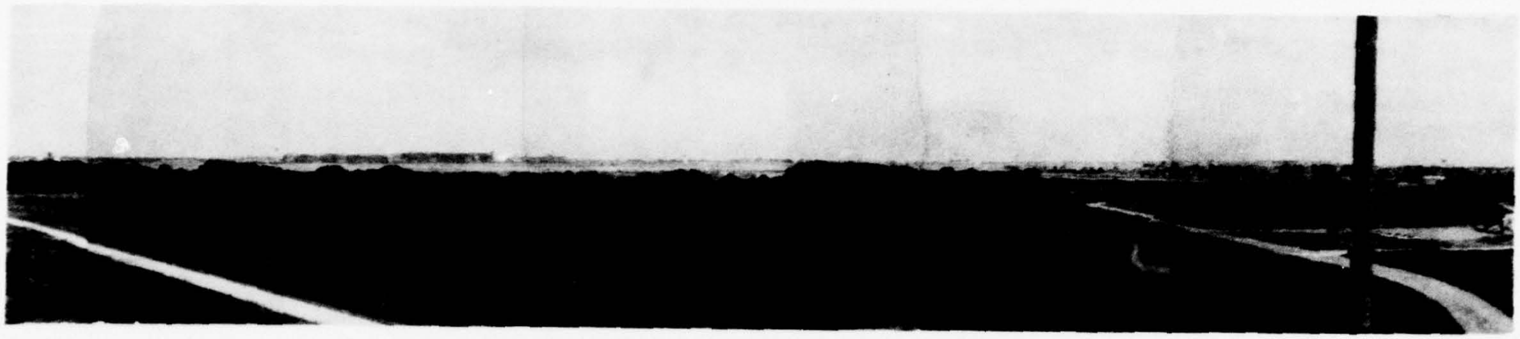
MAGNETIC DECLINATION: 8° E

STATION McCONNELL AFB, KS

EQUIPMENT RECEIVERS

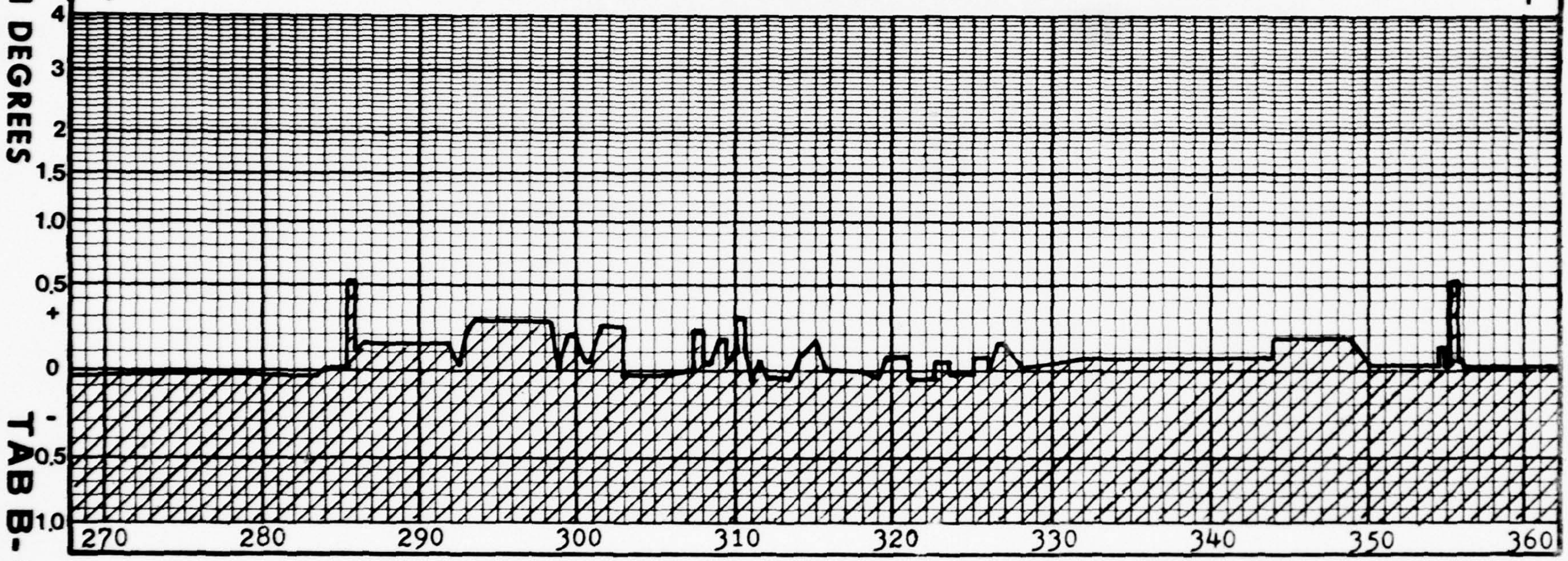
AFCS FORM MAY 73 913

SKYLINE GRAPH



1-9

DISTANCE TO FAR HORIZON IN NAUTICAL MILES.



ORIENTED TO: MAGNETIC NORTH

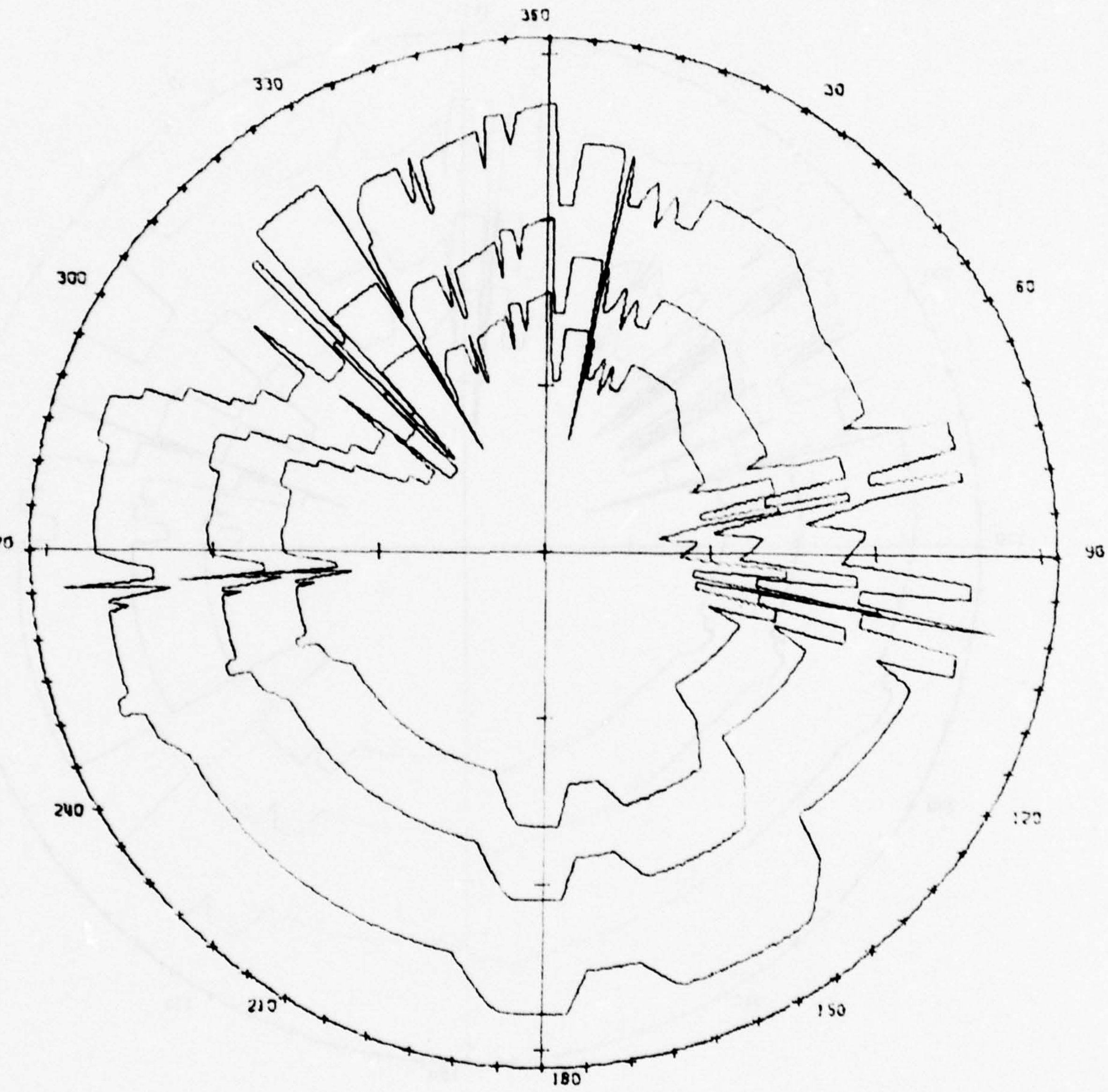
MAGNETIC DECLINATION: 8° E

STATION McCONNELL AFB, KS

EQUIPMENT RECEIVERS

AFCS FORM MAY 73 913

LINE OF SIGHT COVERAGE (RLS)

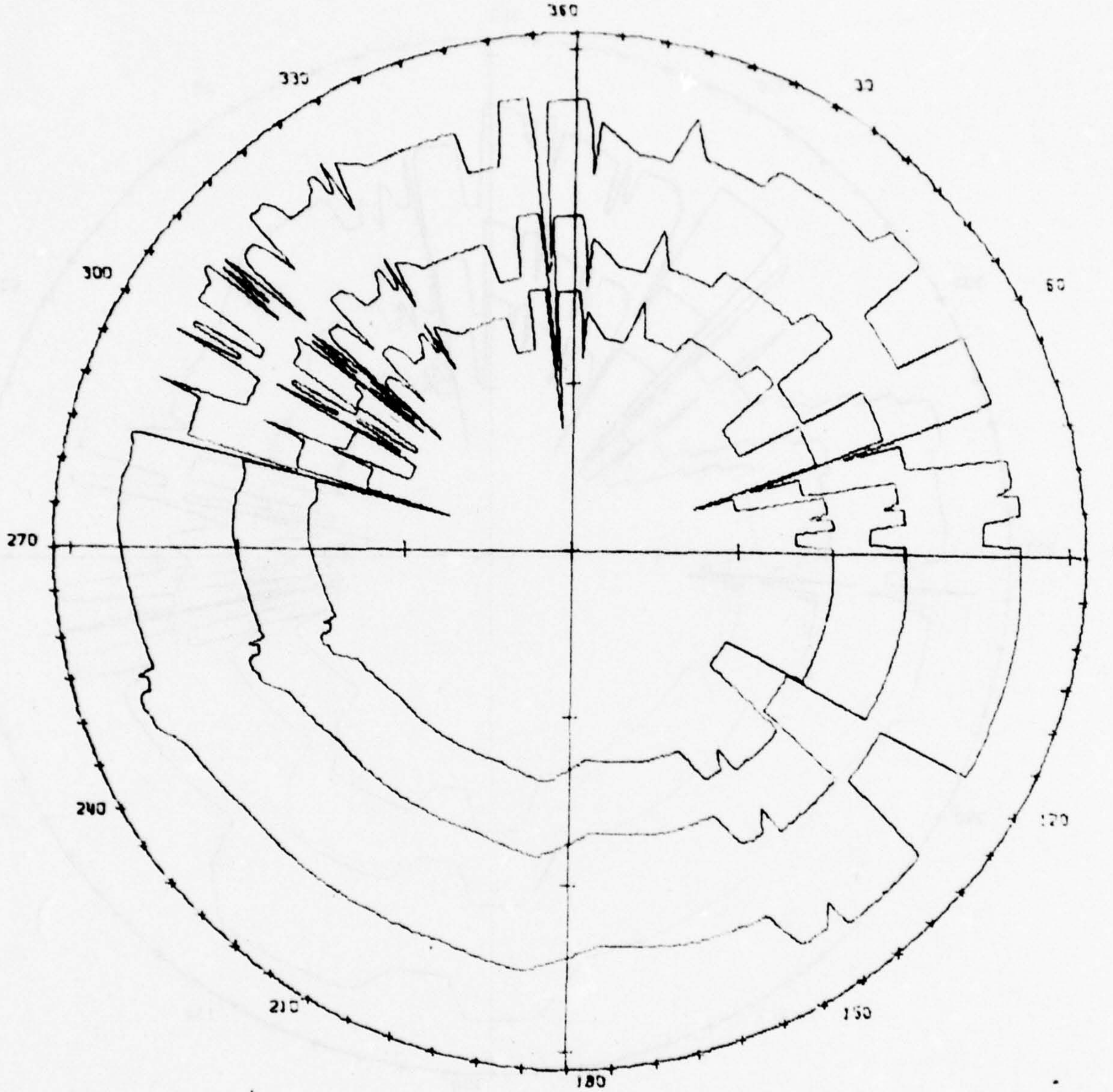


MCCONNELL AFB
TRANSMITTERS
12 JUL 78
ANTENNA ELEVATION 1381 FT MSL
SCALE: 1 INCH = 30 NM
ORIENTED TO MAGNETIC NORTH

ALTITUDES FT. MSL
3000
4000
6000

VARIATION 8 DEG E

LINE OF SIGHT COVERAGE (RLS)



MCCONNELL AFB
RECEIVERS
12 JUL 78
ANTENNA ELEVATION 1400 FT MSL
SCALE: 1 INCH = 30 NM
ORIENTED TO MAGNETIC NORTH

ALTITUDES FT. MSL
3000
4000
6000

VARIATION 8 DEG E

TITLE

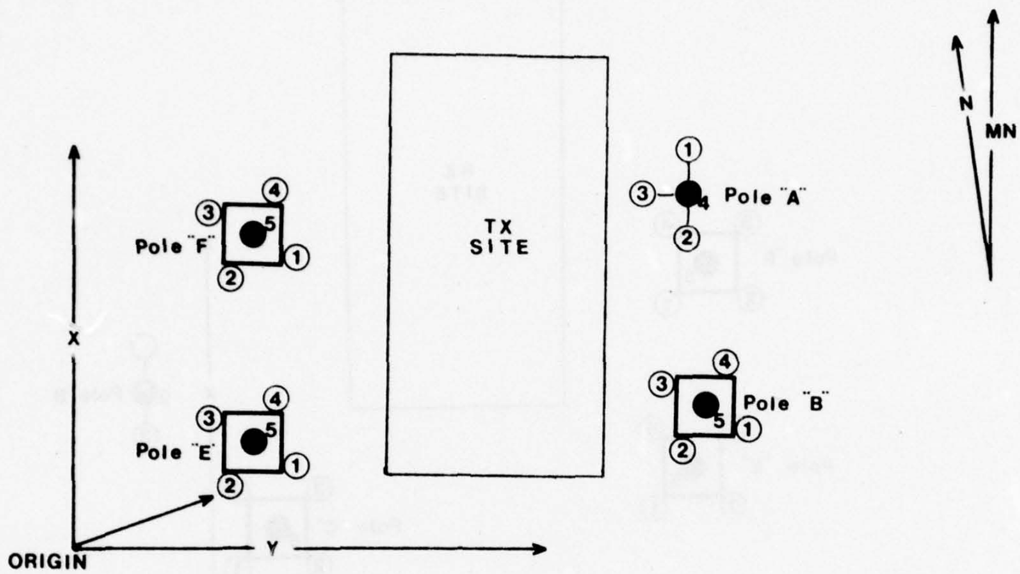
TRANSMITTER SITE ANTENNA LAYOUT

LOCATION

McConnell AFB, KS

DATE

July 1978



POLE/ANT	X	Y	Z(MSL)	TYPE	FREQ(MHZ)
A/1	44.6	75.7	1374.7	AT-197	SPARE UHF
A/2	37.4	75.6	1375.8	AS-1181	121.5
A/3	42.0	71.9	1376.5	AT-197	SPARE
A/4	41.6	76.4	1379.1	AS-1181	SPARE
B/1	14.3	86.3	1378.9	AT-197	351.1
B/2	10.0	78.6	1378.8	AT-197	269.1
B/3	18.8	75.2	1378.5	AT-197	339.3
B/4	22.4	82.7	1379.1	AT-197	302.2
B/5	16.2	80.7	1383.5	AS-1097	MULTI
E/1	3.8	6.7	1380.2	AT-197	372.2
E/2	0	0	1379.9	AT-197	MULTI
E/3	8.2	-4.7	1379.7	AT-197	SPARE
E/4	9.3	3.0	1381.1	AS-1181	SPARE
E/5	6.0	2.1	1381.1	AS-1097	295.7/342.5/372.2/ 271.9
F/1	27.8	3.7	1380.4	AT-197	239.8
F/2	23.9	-2.8	1381.1	AT-197	SPARE UHF
F/3	32.5	-7.3	1380.2	AT-197	SPARE
F/4	35.9	-0.2	1380.2	AT-197	275.8/236.6/243.0
F/5	29.9	-2.1	1382.0	AS-1181	126.2

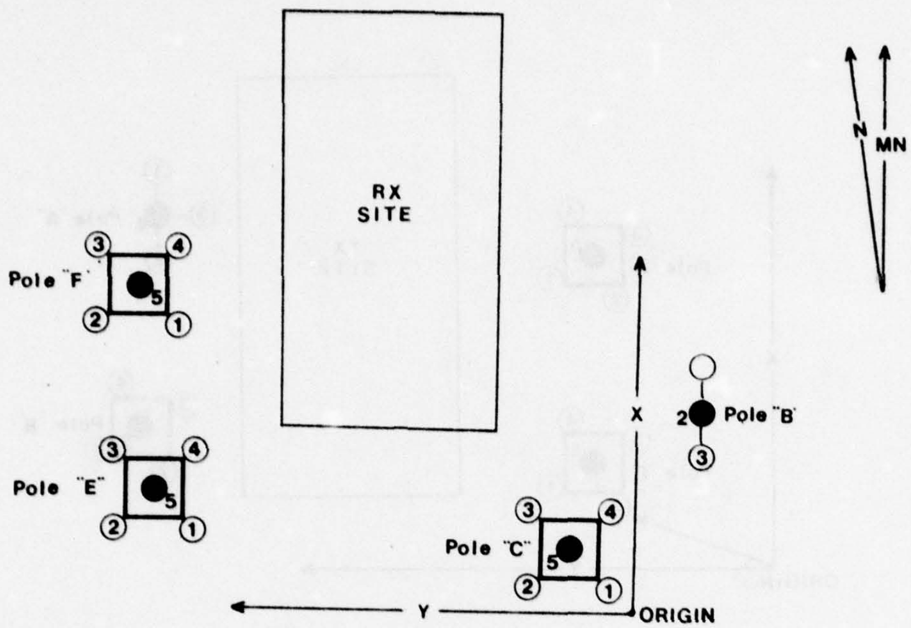
REMARKS

All measurements in feet from antenna E/2. Site elevation: 1330 feet MSL.

TITLE

RECEIVER SITE ANTENNA LAYOUT

LOCATION	DATE
McConnell AFB, KS	July 1978



POLE/ANT	X	Y	Z(MSL)	TYPE	FREQ(MHZ)
B/1	30.8	-3.4	1395.0	AT-197	302.2
B/2	26.8	-2.8	1399.1	AS-1181	126.2
B/3	24.5	-3.2	1394.7	AT-197	307.9
C/1	0.0	0.0	1408.6	AS-1181	SPARE
C/2	2.8	5.0	1405.6	AT-197	243.0/236.6/295.7/ 275.8
C/3	10.4	1.6	1406.4	AT-197	339.3
C/4	7.2	-6.4	1406.3	AT-197	SPARE
C/5	4.3	0.1	1411.7	AS-1097	339.3/269.1/351.1/ 302.2
E/1	10.7	74.0	1399.4	AT-197	SPARE
E/2	8.2	84.1	1399.4	AT-197	311.0
E/3	18.0	84.2	1399.3	AT-197	321.0
E/4	17.0	74.7	1399.8	AT-197	SPARE
E/5	13.6	78.1	1401.6	AS-1181	121.5
F/1	31.5	82.9	1396.5	AT-197	SPARE
F/2	36.6	89.3	1396.6	AT-197	SPARE
F/3	42.6	87.3	1396.7	AT-197	SPARE
F/4	39.6	77.9	1397.1	AT-197	372.2/342.5/266.2/ 271.9
F/5	37.7	82.9	1398.1	AS-1097	SPARE

REMARKS

All measurements in feet from antenna C/1. Site elevation 1349 feet MSL

TITLE

EQUIPMENT ANALYSIS SPECIFICATION LIST

LOCATION	DATE
McConnell AFB, KS	July 1978

FREQUENCY: Self Explanatory

1. Equipment Type: Transmitters AN/GRT-21 and AN/GRT-22 (TO 31R2-2GRT-102)

2. Transmitter Serial Number:-----------:	Obtained from equipment
3. Percent of Modulation, 0 dBm Input:-:	90%±10%
4. Percent of Modulation, -15 dBm Input:	90%±10%
5. Percent of Modulation, +10 dBm Input:	90%±10%
6. Distortion:-----------------------:	10% at lower limiting 15% at upper limiting
7. Frequency Accuracy Tolerance:-------:	±0.001% with CR-143 crystal ±0.002% with CR-75 crystal ±0.0005% with freq synthesizer
8. Power Output:----------------------:	10 Watts Minimum, Low power mode 50 Watts Minimum, High power mode
9. Reflected Power:--------------------:	2.5 Watts max, 10 Watts forward 12.5 Watts max, 50 Watts forward
10. Transmission System VSWR:-----------:	Normal operation at carrier power with VSWR not greater than 3 to 1
11. Coupler Loss:-----------------------:	2 dB Maximum (TO 31R1-2GR-142) CU-547
12. Antenna VSWR:-----------------------:	2:1 Maximum (TO 31R1-2GR-241) AS-1097 1.6:1 Maximum (TO 31R1-2GR-161) AT-197

13. Receiver Nomenclature: Receivers AN/GRR-23 and AN/GRR-24 (TO 31R2-2GRR-112)

14. Receiver Serial Number:-------------:	Obtained from equipment
15. Frequency Accuracy Tolerance:-------:	±0.001% with CR-143 crystal ±0.002% with CR-75 crystal ±0.0005% with freq synthesizer
16. Sensitivity:-----------------------:	3 uv Maximum
17. Signal to Noise:-------------------:	10 dB with a 3 uv input
18. Squelch Threshold:-----------------:	3 uv (TO 31R2-2GRR-116WC-1, 28 day inspection)
19. AGC Characteristics:______________:	3 dB Maximum variation with input signal of 6 uv to 1 v
20. Audio Output:----------------------:	+20 dBm
21. Distortion:------------------------:	For frequencies 300, 1,500, and 3000 Hz with a 1 v input 10% maximum with 30% modulation 20% maximum with 90% modulation
22. Transmission System VSWR:-----------:	NSA (No Specifications Available)
23. Antenna VSWR:-----------------------:	2:1 Maximum (TO 31R1-2GR-241) AS-1097 1.6:1 Maximum (TO 31R1-2GR-161) AT-197
24. Coupler Loss:-----------------------:	2 dB Maximum (TO 31R1-2GR-142) CU-547

REMARKS

TITLE

EQUIPMENT ANALYSIS SPECIFICATION LIST

LOCATION

McConnell AFB, KS

DATE

July 1978

FREQUENCY: Self Explanatory

1. Equipment Type: Transmitter AN/GRT-18 (TO 31R2-GRT18-2)

2. Transmitter Serial Number:------------:	Obtained from equipment
3. Percent of Modulation, 0 dBm Input:---:	90% Minimum
4. Percent of Modulation, -15 dBm Input:-:	90% Minimum
5. Percent of Modulation, +10 dBm Input:-:	90% Minimum (50 Watt mode only).
6. Distortion:---------------------------:	NSA (No specification available).
7. Frequency Accuracy Tolerance:---------:	±0.0014% of the assigned frequency.
8. Power Output:-------------------------:	10 Watts Minimum, Low power mode 50 Watts Minimum, High power mode.
9. Reflected Power:----------------------:	1.1 Maximum, 10 Watts forward 5.5 Maximum, 50 Watts forward
10. Transmission System VSWR:------------:	2:1 Maximum
11. Coupler Loss:------------------------:	NA
12. Antenna VSWR:------------------------:	2:1 Maximum (TO 31R1-2UR-31) AS-1181

13. Receiver Nomenclature: Receiver AN/GRR-25 (TO 31R2-2GRR25-2)

14. Receiver Serial Number:--------------:	Obtained from equipment
15. Frequency Accuracy Tolerance:--------:	±0.002%
16. Sensitivity:-------------------------:	5 uv
17. Signal to Noise:---------------------:	10 dB with 5 uv input
18. Squelch Threshold:-------------------:	3 uv maximum at max rf gain
19. AGC Control:-------------------------:	3 dB maximum variation with input signals of 15 uv to 1 v
20. Audio Output:------------------------:	+10 to +30 dBm main audio (-10 to +10 dBm low level)
21. Distortion:--------------------------:	15% Maximum with a 1 v rf input signal modulated at 30% 25% Maximum with a 1 v rf input signal modulated at 90%
22. Transmission System VSWR:------------:	NSA
23. Antenna VSWR:------------------------:	2:1 Maximum (TO 31R1-2UR-31) AS-1181
24. Coupler Loss:------------------------:	NA

REMARKS

AM RADIO COMMUNICATIONS EQUIPMENT ANALYSIS						DATE July 1978
LOCATION McConnell AFB, KS						
FREQUENCY	275.8		121.5		126.2	
1. TRANSMITTER NOMENCLATURE	AN/GRT-22		AN/GRT-21		AN/GRT-18	
2. SERIAL NUMBER	5863		450		527	
	INITIAL	ADJUSTED	INITIAL	ADJUSTED	INITIAL	ADJUSTED
3. MODULATION LEVEL %	90		100+	90	70	90
4. LOWER LIMITING %	90			90		90
5. UPPER LIMITING %	90			90		90
6. DISTORTION %	3.7		27	7	7	
7. FREQUENCY ACCURACY %	.00002		.000004		.001	
8. RF POWER OUT FORWARD Watts	10		9	10	10.5	
9. COUPLER VSWR	1.10:1		N/A		N/A	
10. COUPLER LOSS dB	1.66		N/A		N/A	
11. ANTENNA VSWR	1.08:1		1.22:1		1.14:1	
12. RECEIVER NOMENCLATURE	AN/GRR-24		AN/GRR-25		AN/GRR-25	
13. SERIAL NUMBER	2989		6440		65171	
14. FREQUENCY ACCURACY %	.00000		.0003		.0008	
15. SENSITIVITY UV	4		1.2		1.6	
16. SIGNAL TO NOISE dB	*8:1		22:1		20:1	
17. SQUELCH THRESHOLD UV	2.6	3	2.8	3	1.8	3
18. AGC	.8		.7		1.1	
19. AUDIO OUT dBm	21	20	-11.6		-9.4	
20. DISTORTION %	3		12.1		5.2	
21. COUPLER VSWR	1.01:1		N/A		N/A	
22. COUPLER LOSS dB	1.94		N/A		N/A	
23. ANTENNA VSWR	4.45:1		3.62:1		3.14:1	

REMARKS

* Not repaired during the evaluation.

AFCS FORM OCT 76 957 PREVIOUS EDITION IS OBSOLETE

TAB: E-2-1

AM RADIO COMMUNICATIONS EQUIPMENT ANALYSIS

DATE: July 1978

LOCATION: McConnell AFB, KS

FREQUENCY	399.3		351.1		302.2	
1. TRANSMITTER NOMENCLATURE	AN/GRT-22		AN/GRT-22		AN/GRT-22	
2. SERIAL NUMBER	5099		14059		16385	
	INITIAL	ADJUSTED	INITIAL	ADJUSTED	INITIAL	ADJUSTED
3. MODULATION LEVEL %	70	90	80	90	80	90
4. LOWER LIMITING %		90		90		90
5. UPPER LIMITING %		90		90		90
6. DISTORTION %	11	4.6	4.2		3.7	
7. FREQUENCY ACCURACY %	.00005		.00006		.00009	
8. RF POWER OUT FORWARD Watts	11.5	10	10.5	10	11.6	10
9. COUPLER VSWR	1.01:1		1.06:1		N/A	
10. COUPLER LOSS dB	1.36		3.85		N/A	
11. ANTENNA VSWR	1.05:1		1.18:1		1.01:1	
12. RECEIVER NOMENCLATURE	AN/GRR-24		AN/GRR-24		AN/GRR-24	
13. SERIAL NUMBER	7678		3331		3301	
14. FREQUENCY ACCURACY %	.00000		.00000		.00000	
15. SENSITIVITY UV	2		1.7			1.9
16. SIGNAL TO NOISE dB	11:1		14:1		6:1	14:1
17. SQUELCH THRESHOLD UV	2.5	3	2.85	3	2.75	3
18. AGC	.8		2.1		1.2	
19. AUDIO OUT dBm	21.8	20	20		21.6	20
20. DISTORTION %	4.0		4.8		8.1	
21. COUPLER VSWR	1.55:1		1.01:1		1.14:1	
22. COUPLER LOSS dB	3.1		1.58		1.94	
23. ANTENNA VSWR	3:1		3:1		3:1	

REMARKS

TITLE

AMPLIFIER DATA

LOCATION	DATE
GCA	July 1978

Microphone Amplifier

Serial Number							
Position		Bay 13					
Input Level	(VRMS)	3					
Output Level	(VRMS)	3					
% Distortion	(5% Max)	1					
Noise Level	(dBm)	-24					
Input at Limiting	(dBm)	NA					
Output at Limiting	(dBm)	NA					

Line Amplifier

Frequency		351.1	302.2	339.3			
Input Level	(dBm)	-2	-2	-2			
Output Level	(dBm)	11	11.2	11			
% Distortion	(5% Max)	12	14	16			
Noise Level	(dBm)	-29	-26	-28			

Line Amplifier

Frequency							
Input Level	(dBm)						
Output Level	(dBm)						
% Distortion	(5% Max)						
Noise Level	(dBm)						

REMARKS

TITLE

AMPLIFIER DATA

LOCATION	DATE
Control Tower	July 1978

Type AM-4568/G Microphone Amplifier

Serial Number		470	464	484	92		
Position		Maint.	3	2	1		
Input Level	(dBm)	-35	-35	-35	-35		
Output Level	(dBm)	15	15	15	15		
% Distortion	(5% Max)	2.45	2.5	2.5	2.5		
Noise Level	(dBm)	-48	-64	-73.5	-73		
Input at Limiting	(dBm)	-42	-41	-38	-42		
Output at Limiting	(dBm)	-3	-2	2.5	-3		

Type AM-4571/G Line Amplifiers

Frequency		121.5	275.8	126.2			
Input Level	(dBm)	-4	-4	-4			
Output Level	(dBm)	27	27	27			
% Distortion	(5% Max)	2.1	1.7	1.7			
Noise Level	(dBm)	-56	-54	-58			

Type AM-4571/G Position Amplifiers

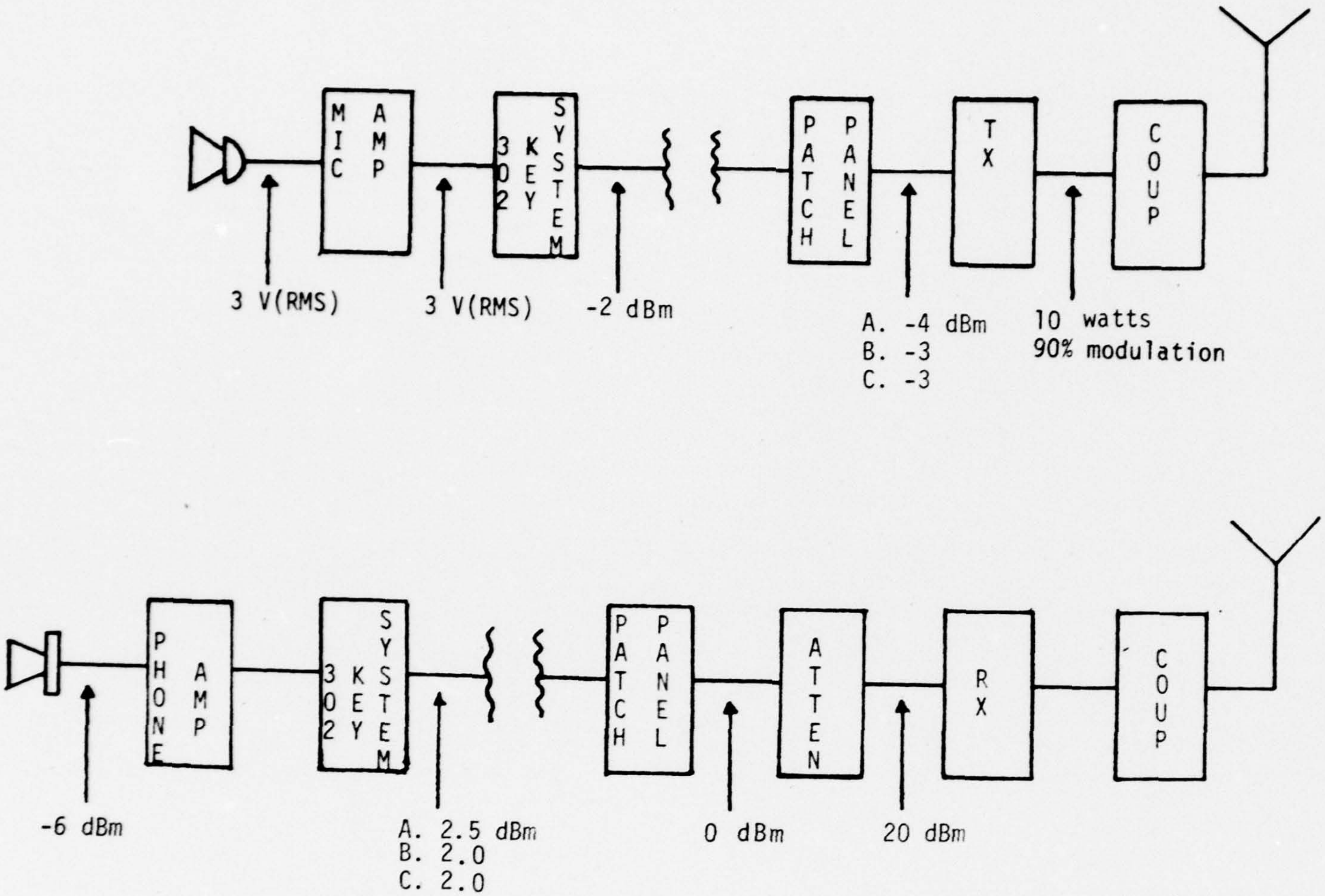
Position 3		Sp	PH				
Input Level	(dBm)	-43	-45				
Output Level	(dBm)	15	6				
% Distortion	(5% Max)	3.2	1.4				
Noise Level	(dBm)	-58	-47				

REMARKS

AM RADIO COMMUNICATIONS SYSTEM LOOP ANALYSIS		DATE July 1978						
LOCATION: GCA								
1. FREQUENCY:		351.1	302.2	339.3				
2. MIC AMP IN	VRMS	3	3	3				
3. MIC AMP OUT	VRMS	3	3	3				
4. NOISE FLOOR	dB Down	43	45	43				
5. NOISE LEVEL	dBm	-24	-24	-24				
6. CABLE IN	dBm	-2	-2	-2				
7. NOISE FLOOR	dB Down	17	28	28				
8. NOISE LEVEL	dBm	-13	-24	-21.5				
9. CABLE OUT	dBm	-4	-3	-3				
10. NOISE FLOOR	dB Down	9	16.5	17				
11. NOISE LEVEL	dBm	-13	-20	-21				
12. TRANSMITTER IN	dBm	-4	-3	-3				
13. % MODULATION	%	90	90	90				
14. POWER OUT	Watts	10	10	10				
15. RECEIVER OUT	dBm	20	20	20				
16. NOISE FLOOR	dB Down	16.2	14.6	15				
17. NOISE LEVEL	dBm	-26.2	-25	-26				
18. CABLE IN	dBm	0	0	0				
19. NOISE FLOOR	dB Down	16.2	14.6	15				
20. NOISE LEVEL	dBm	-26.2	-25	-26				
21. CABLE OUT	dBm	-2.5	-2	-2				
22. NOISE FLOOR	dB Down	17	15	15				
23. NOISE LEVEL	dBm	-30	-28	-48				
24. SPEAKER AMP IN	dBm	11	11.5	11				
25. SPEAKER AMP OUT	dBm	-6	-6	-6				
26. NOISE FLOOR	dB Down	15	14.5	14.5				
27. NOISE LEVEL	dBm	-50	-53	-47				
28. 2ND HARMONIC LEVEL								
29. 3RD HARMONIC LEVEL								

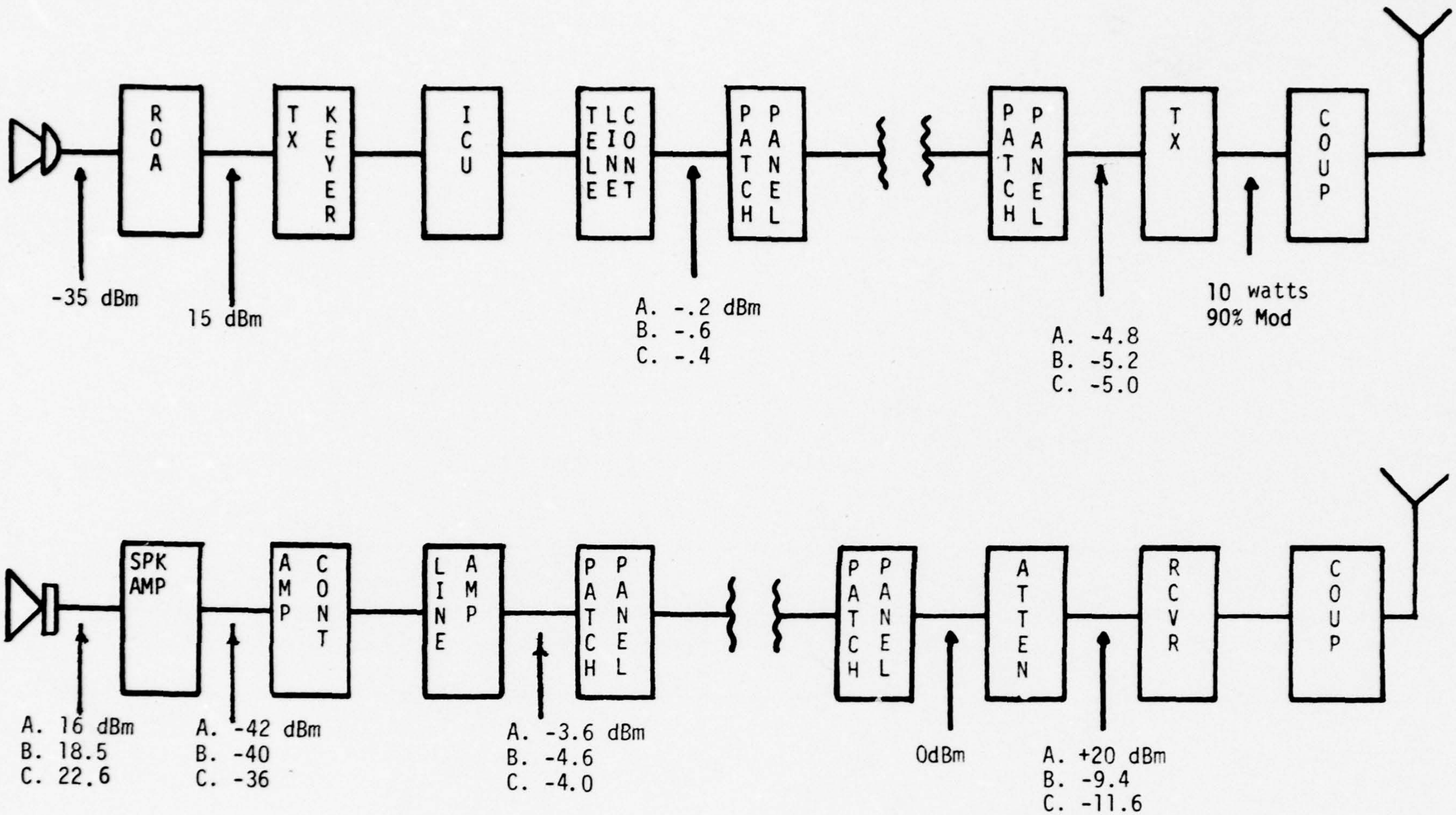
AM RADIO COMMUNICATIONS SYSTEM LOOP ANALYSIS					DATE July 1978		
LOCATION: Control Tower							
1. FREQUENCY:	275.8	126.2	121.5				
2. MIC AMP IN dBm	-35	-35	-35				
3. MIC AMP OUT dBm	15	15	15				
4. NOISE FLOOR dB Down	32	32	32.5				
5. NOISE LEVEL dBm	-40	-39	-42				
6. CABLE IN dBm	-.2	-.6	-.4				
7. NOISE FLOOR dB Down	26	23.5	23.5				
8. NOISE LEVEL dBm	-28	-25	-25				
9. CABLE OUT dBm	-4.8	-5.2	-5				
10. NOISE FLOOR dB Down	16	13	13.5				
11. NOISE LEVEL dBm	-21.5	-18.5	-19				
12. TRANSMITTER IN dBm	-4.8	-5.2	-5				
13. % MODULATION %	90	85	85				
14. POWER OUT Watts	10	10	10				
15. RECEIVER OUT dBm	20	-9.4	-11.6				
16. NOISE FLOOR dB Down	22	15	15.4				
17. NOISE LEVEL dBm	-24.4	-25.8	-25				
18. CABLE IN dBm	0	0	0				
19. NOISE FLOOR dB Down	22	15	15.4				
20. NOISE LEVEL dBm	-24.4	-25.8	-25				
21. CABLE OUT dBm	-3.6	-4.6	-4				
22. NOISE FLOOR dB Down	23	15	15.8				
23. NOISE LEVEL dBm	-29	-30	-29				
24. SPEAKER AMP IN dBm	-42	-40	-36.5				
25. SPEAKER AMP OUT dBm	16	18.5	22				
26. NOISE FLOOR dB Down	13	15.5	15.5				
27. NOISE LEVEL dBm	-32	-31	-31.5				
28. 2ND HARMONIC LEVEL							
29. 3RD HARMONIC LEVEL							

AFCS FORM JAN 75 958 REVISED



LOOP TEST LINE LEVEL DIAGRAM
(GCA)

Frequency
A. 351.1
B. 302.2
C. 339.3



LOOP TEST LINE LEVEL DIAGRAM
(CONTROL TOWER)

Frequency
A. 275.8
B. 126.2
C. 121.5

A. C. POWER							DATE July 1978
LOCATION Transmitter Site				EQUIPMENT & SERIAL NUMBER			

CHECK	SPECIFICATIONS	PRIME POWER			STANDBY POWER		
1. VISUAL INSPECTION		SAT			SAT		
2. REGULATOR INPUT		VOLTAGE		CURRENT	VOLTAGE		CURRENT
		INITIAL	ADJUSTED		INITIAL	ADJUSTED	
PHASE A		118		40	125		20
PHASE B		118		39	125		18
PHASE C		118		36	125		13.5
NEUTRAL				1.5			
3. REGULATOR OUTPUT							
PHASE A							
PHASE B							
PHASE C							
NEUTRAL							

GENERATOR	MANUFACTURER Federal	TYPE Diesel	SERIAL NUMBER JB 7440B15
	CAPACITY 30kW	FREQUENCY 60	LOAD 20%
AUTOMATIC CHANGEOVER	MANUFACTURER Lake Shore	TYPE Auto	CHANGEOVER INTERVAL 12 sec

VOLTAGE REGULATOR RESPONSE

VOLTAGE REGULATOR	SPECIFICATION	AS FOUND	ADJUSTED TO: MANUALLY	ADJUSTED TO: AUTOMATIC	TIME TO ADJUST
PHASE A					
PHASE B					
PHASE C					

EQUIPMENT GROUNDING:

REMARKS:

A. C. POWER	DATE July 1978
LOCATION Receiver Site	EQUIPMENT & SERIAL NUMBER

CHECK	SPECIFICATIONS	PRIME POWER			STANDBY POWER		
1. VISUAL INSPECTION		SAT			SAT		
2. REGULATOR INPUT		VOLTAGE		CURRENT	VOLTAGE		CURRENT
		INITIAL	ADJUSTED		INITIAL	ADJUSTED	
PHASE A		117			117		
PHASE B							
PHASE C							
NEUTRAL							
3. REGULATOR OUTPUT							
PHASE A							
PHASE B							
PHASE C							
NEUTRAL							

GENERATOR	MANUFACTURER Lima	TYPE Gas	SERIAL NUMBER A 5293KA
	CAPACITY 5kW	FREQUENCY 60	LOAD 50%
AUTOMATIC CHANGEOVER	MANUFACTURER Lima	TYPE Auto	CHANGEOVER INTERVAL 10 sec

VOLTAGE REGULATOR RESPONSE

VOLTAGE REGULATOR	SPECIFICATION	AS FOUND	ADJUSTED TO:		TIME TO ADJUST
			MANUALLY	AUTOMATIC	
PHASE A					
PHASE B					
PHASE C					

EQUIPMENT GROUNDING:

REMARKS:

A. C. POWER							DATE July 1978
LOCATION GCA			EQUIPMENT & SERIAL NUMBER				
CHECK	SPECIFICATIONS	PRIME POWER			STANDBY POWER		
1. VISUAL INSPECTION		SAT			SAT		
2. REGULATOR INPUT		VOLTAGE		CURRENT	VOLTAGE		CURRENT
		INITIAL	ADJUSTED		INITIAL	ADJUSTED	
PHASE A		125		115	125		110
PHASE B		125		98	125		100
PHASE C		125		110	125		110
NEUTRAL				7			
3. REGULATOR OUTPUT							
PHASE A							
PHASE B							
PHASE C							
NEUTRAL							

GENERATOR			
GENERATOR	MANUFACTURER General Electric	TYPE Diesel	SERIAL NUMBER 3SJ4404
	CAPACITY 60kW	FREQUENCY 60	LOAD 46%
AUTOMATIC CHANGEOVER	MANUFACTURER Lake Shore	TYPE Auto	CHANGEOVER INTERVAL 10 sec

VOLTAGE REGULATOR RESPONSE

VOLTAGE REGULATOR	SPECIFICATION	AS FOUND	ADJUSTED TO: MANUALLY	ADJUSTED TO: AUTOMATIC	TIME TO ADJUST
PHASE A					
PHASE B					
PHASE C					

EQUIPMENT GROUNDING:

REMARKS:

A. C. POWER							DATE July 1978
LOCATION Control Tower			EQUIPMENT & SERIAL NUMBER				

CHECK	SPECIFICATIONS	PRIME POWER			STANDBY POWER		
1. VISUAL INSPECTION		SAT			SAT		
2. REGULATOR INPUT		VOLTAGE		CURRENT	VOLTAGE		CURRENT
		INITIAL	ADJUSTED		INITIAL	ADJUSTED	
PHASE A		125		6.5	127		7.0
PHASE B		125		11	127		11.5
PHASE C		125		10	127		11
NEUTRAL							
3. REGULATOR OUTPUT							
PHASE A							
PHASE B							
PHASE C							
NEUTRAL							

GENERATOR	MANUFACTURER General Electric	TYPE Diesel	SERIAL NUMBER 55J4324PSY8
	CAPACITY 30kW	FREQUENCY 60	LOAD 10%
AUTOMATIC CHANGEOVER	MANUFACTURER Lake Shore	TYPE Auto	CHANGEOVER INTERVAL 13 sec

VOLTAGE REGULATOR RESPONSE

VOLTAGE REGULATOR	SPECIFICATION	AS FOUND	ADJUSTED TO: MANUALLY	ADJUSTED TO: AUTOMATIC	TIME TO ADJUST
PHASE A					
PHASE B					
PHASE C					

EQUIPMENT GROUNDING:

REMARKS:

TITLE

RSL MEASUREMENT FLIGHT PROFILE

LOCATION: McConnell AFB, KS

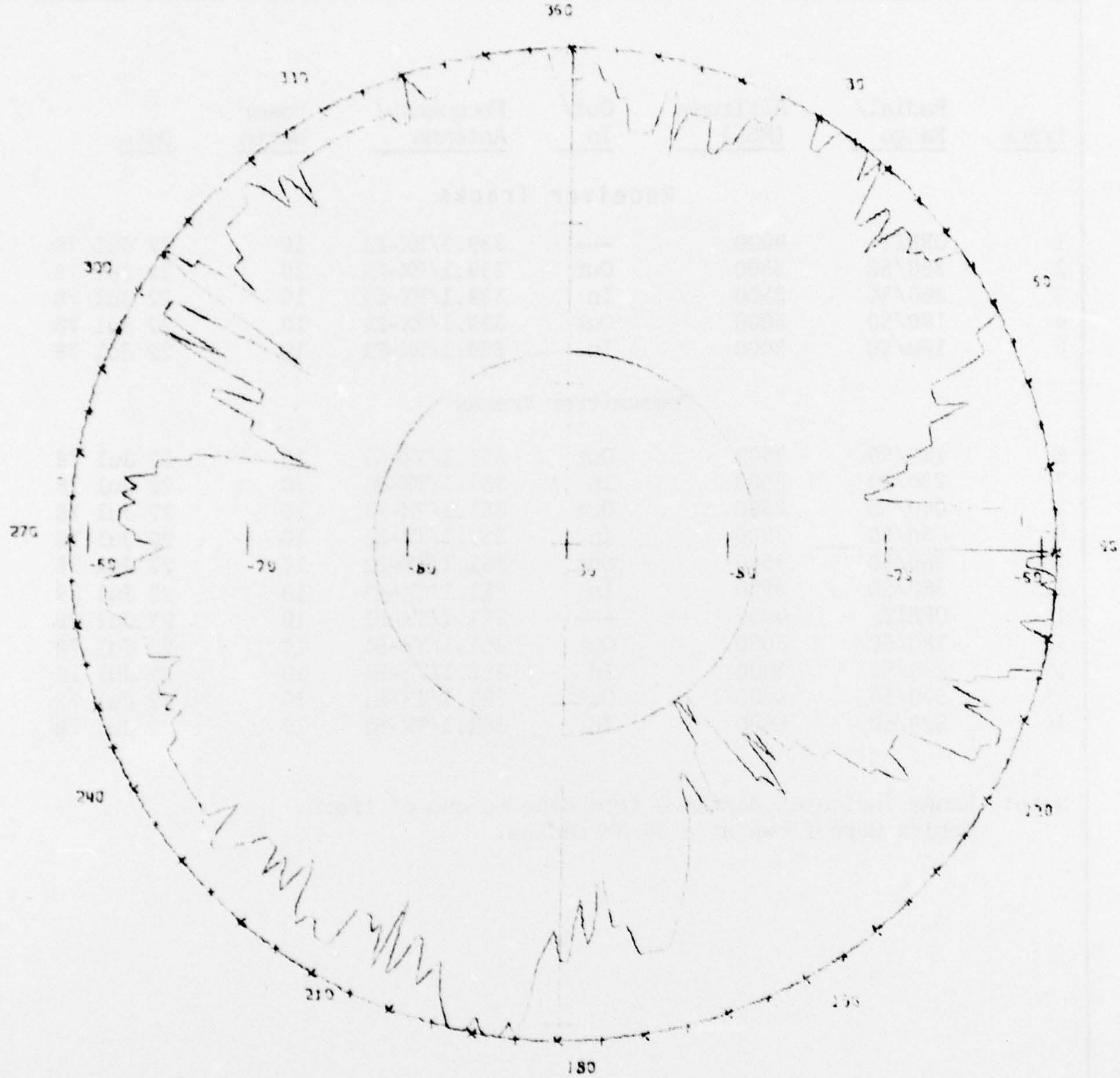
DATE: July 1978

Track	Radial/ Range	Altitude (MSL)	Out/ In	Frequency/ Antenna	Power Watts	Date
			Receiver Tracks			
1	ORBIT	4000	---	339.1/RX-E1	10	22 Jul 78
2	360/50	3500	Out	339.1/RX-E1	10	22 Jul 78
3	360/50	3500	In	339.1/RX-E1	10	22 Jul 78
4	180/50	3000	Out	339.1/RX-E1	10	22 Jul 78
5	180/50	3000	In	339.1/RX-E1	10	22 Jul 78
			Transmitter Tracks			
6	230/50	3500	Out	351.1/TX-B1	10	22 Jul 78
7	230/50	3500	In	351.1/TX-B1	10	22 Jul 78
8	080/50	3500	Out	351.1/TX-B1	10	22 Jul 78
9	080/50	3500	In	351.1/TX-B1	10	22 Jul 78
10	360/50	3500	Out	351.1/TX-B1	10	22 Jul 78
11	360/50	3500	In	351.1/TX-B1	10	22 Jul 78
12	ORBIT	4000	---	351.1/TX-B1	10	22 Jul 78
13	180/50	3000	Out	351.1/TX-B1	10	22 Jul 78
14	180/50	3000	In	351.1/TX-B1	10	22 Jul 78
15	320/50	6000	Out	351.1/TX-B1	10	22 Jul 78
16	320/50	6000	In	351.1/TX-B1	10	22 Jul 78

Note: Range indicates distance from base to end of track.
Orbits were flown at a 30 NM radius.

REMARKS

MEASURED SIGNAL STRENGTH

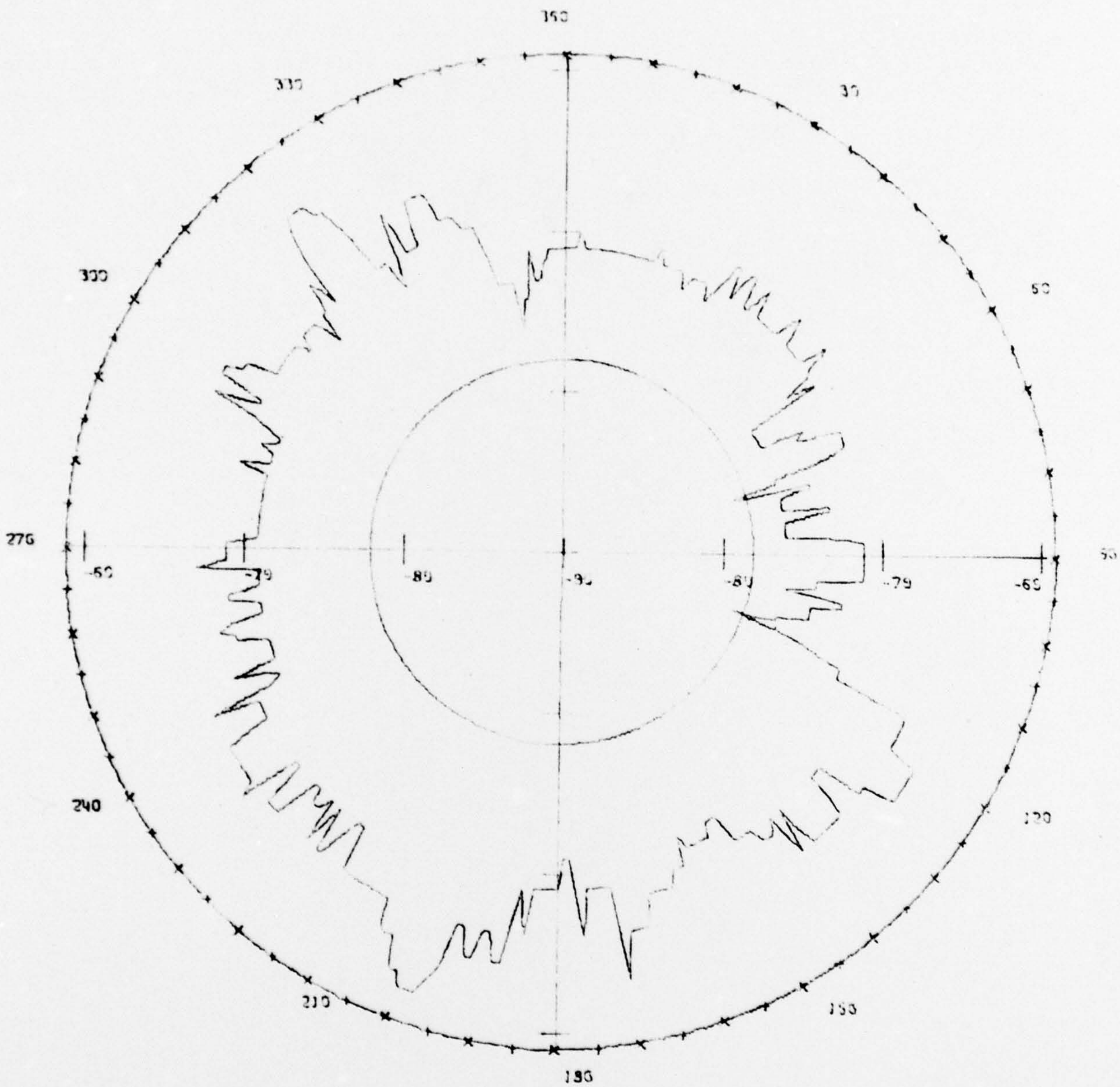


MCCONNELL AFB
TRANSMITTER SITE
AN/GRT-22

RANGE 30 NM.
ALTITUDE 4000 FT. MSL
FREQUENCY 351.10 MHZ

VARIATION 8 DEGREES EAST
SCALE 1 INCH = 10 DB
ORIENTED TO MAGNETIC NORTH
-87 DBM = 10 UVOLTS
22 JUL 78

MEASURED SIGNAL STRENGTH



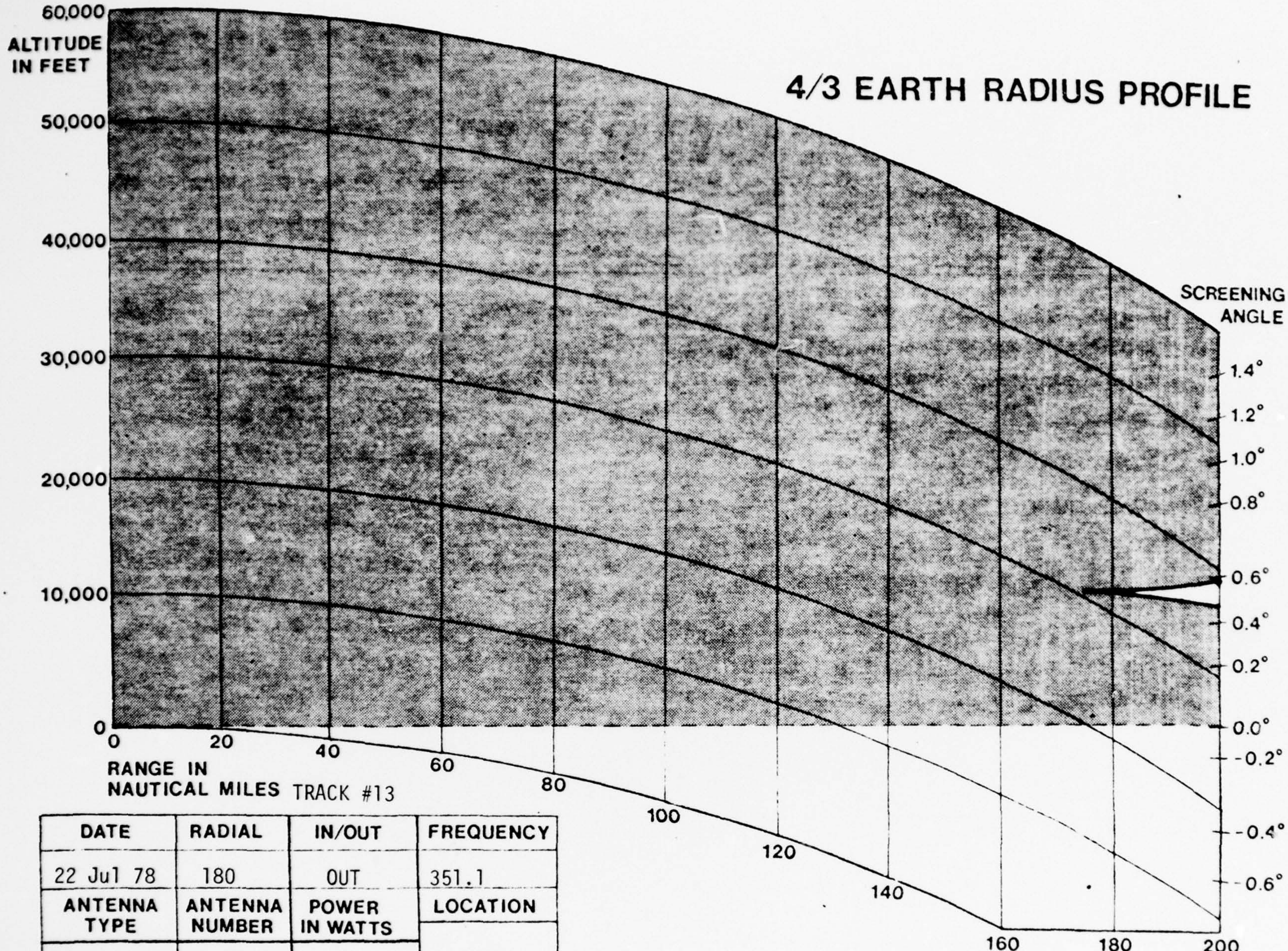
MCCONNELL AFB
RECIEVER SITE
AN/GRR-24

RANGE 30 NM.
ALTITUDE 4000 FT. MSL
FREQUENCY 339.30 MHZ

VARIATION 8 DEGREES EAST
SCALE 1 INCH = 10 DB
ORIENTED TO MAGNETIC NORTH
-87 DBM = 10 UVOLTS
22 JUL 78

TAB: F-2-2

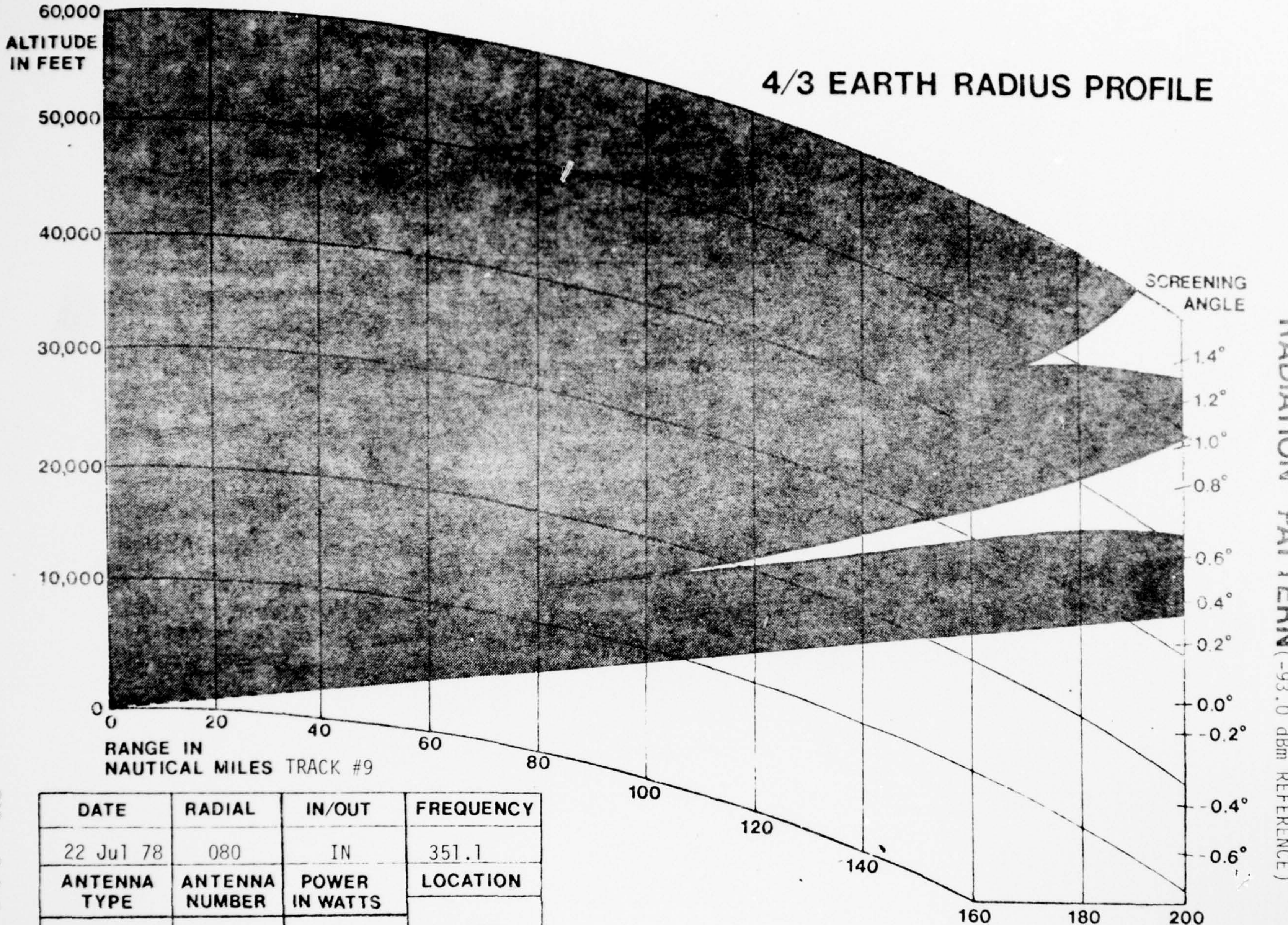
RADIATION PATTERN (-93.0 dBm REFERENCE)



TRACK #13

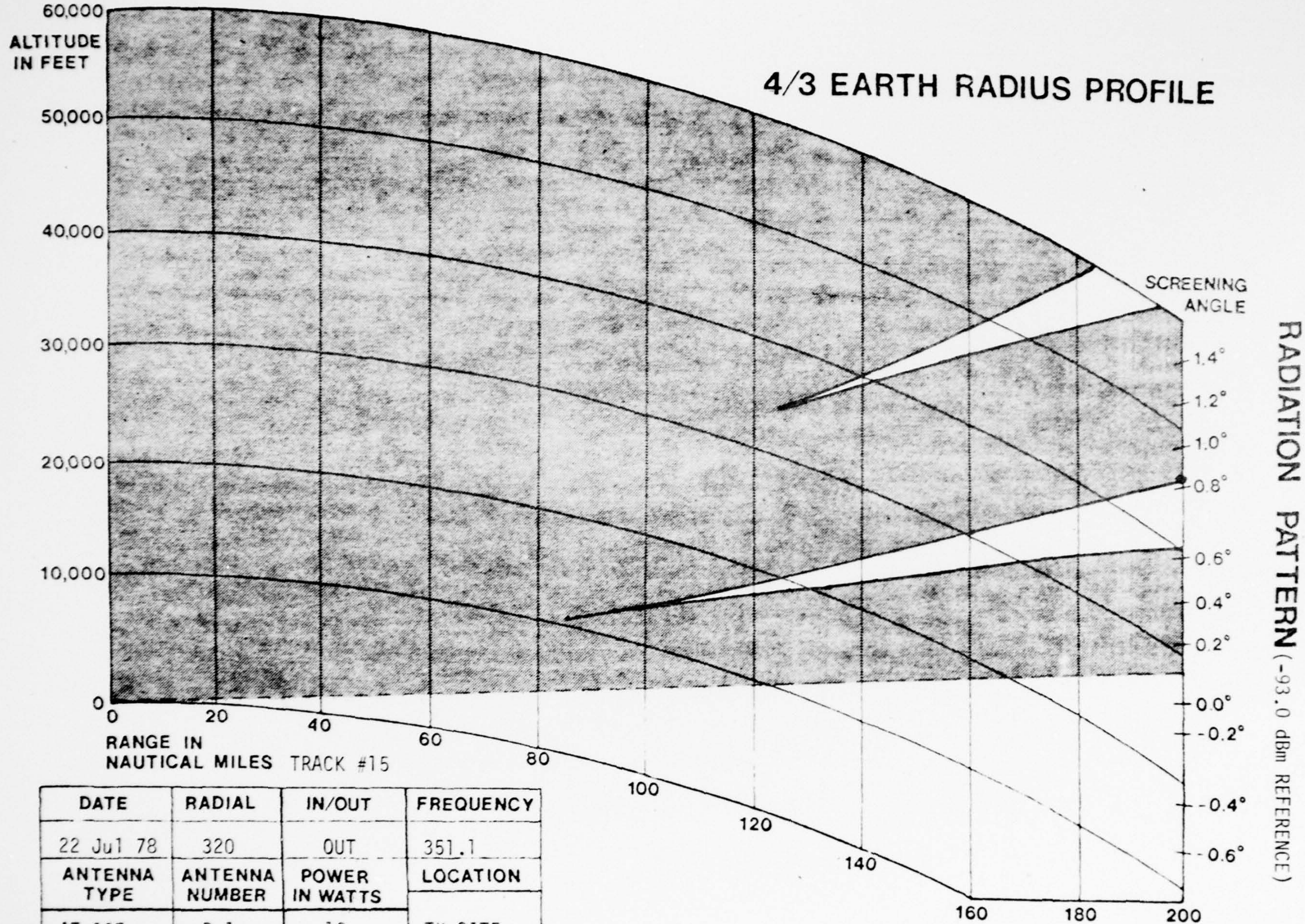
DATE	RADIAL	IN/OUT	FREQUENCY
22 Jul 78	180	OUT	351.1
ANTENNA TYPE	ANTENNA NUMBER	POWER IN WATTS	LOCATION
AT-197	B-1	10	TX-SITE

TAB: F-3-1



DATE	RADIAL	IN/OUT	FREQUENCY
22 Jul 78	080	IN	351.1
ANTENNA TYPE	ANTENNA NUMBER	POWER IN WATTS	LOCATION
AT-197	B-1	10	TX-SITE

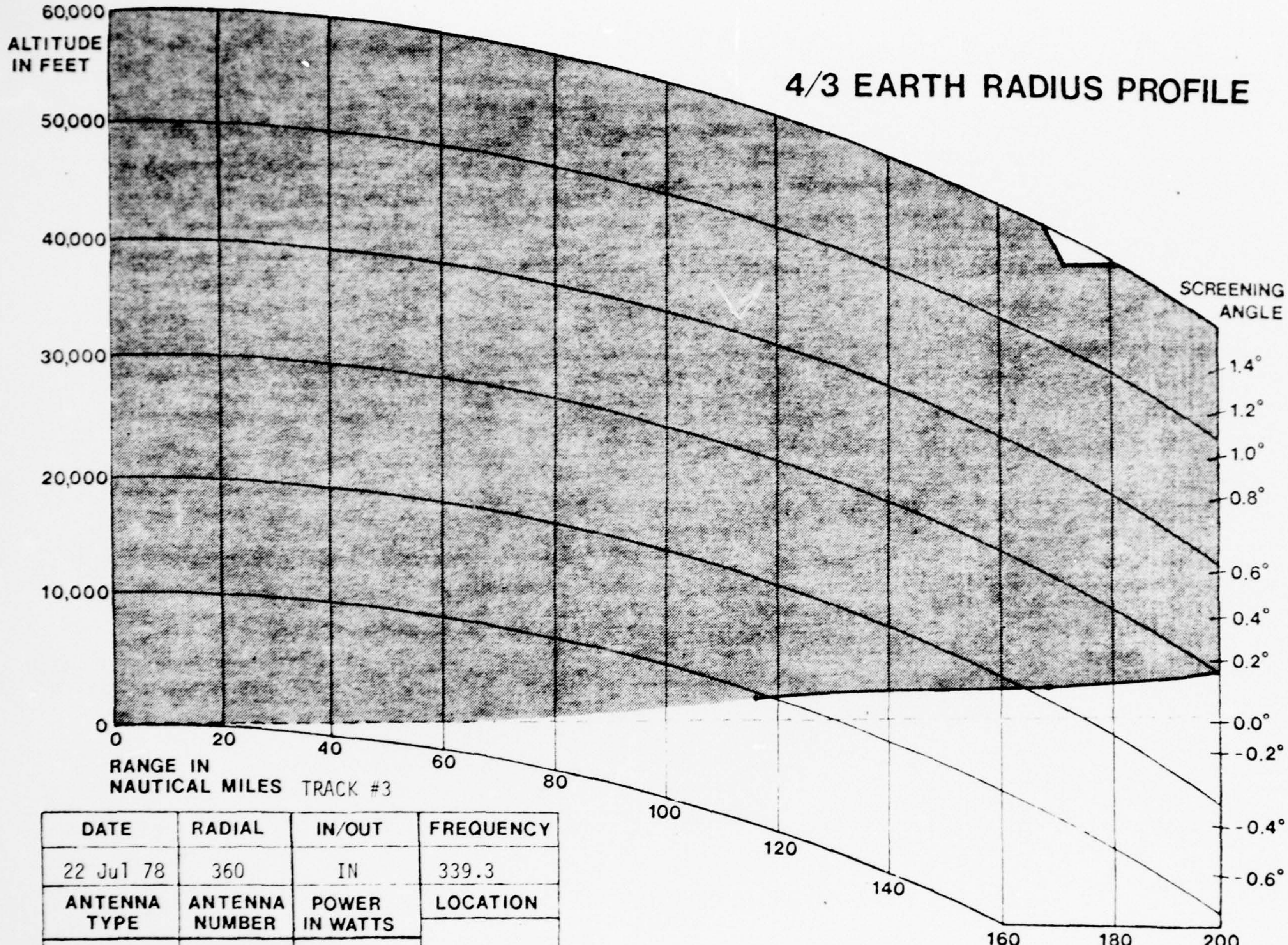
TAB: F-3-2



DATE	RADIAL	IN/OUT	FREQUENCY
22 Jul 78	320	OUT	351.1
ANTENNA TYPE	ANTENNA NUMBER	POWER IN WATTS	LOCATION
AT-197	B-1	10	TX-SITE

RADIATION PATTERN (-97.5 dBm REFERENCE)

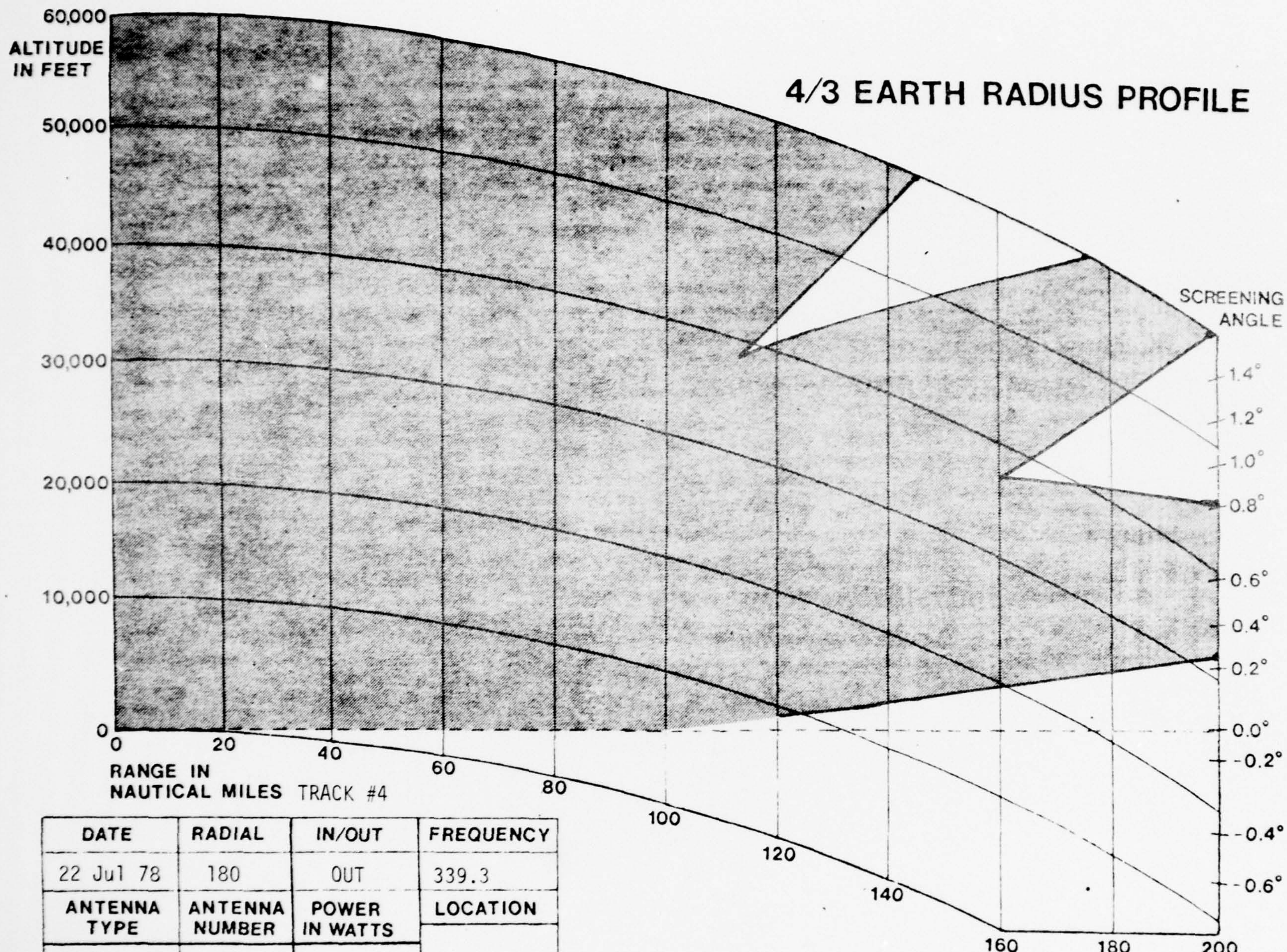
4/3 EARTH RADIUS PROFILE



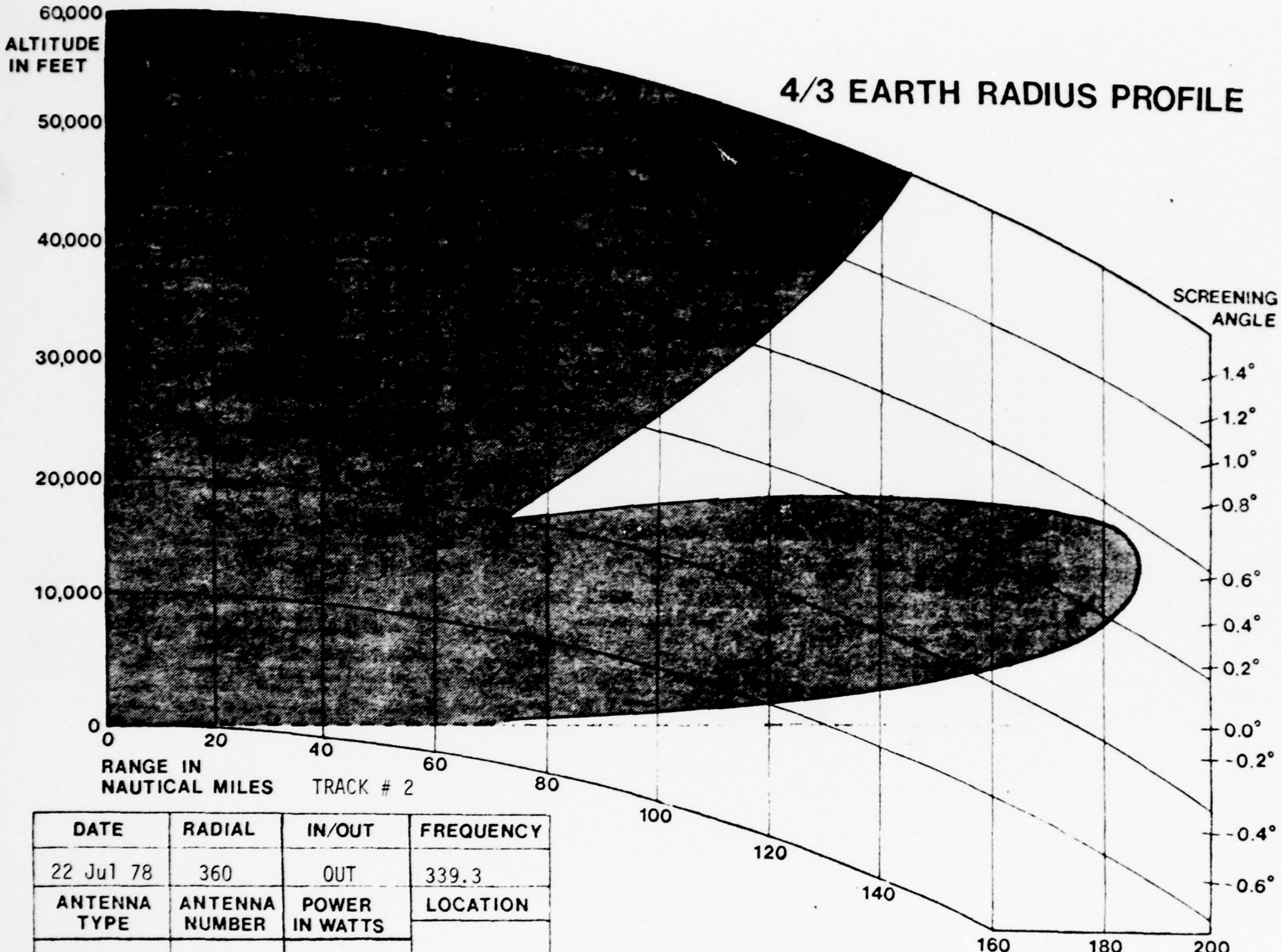
DATE	RADIAL	IN/OUT	FREQUENCY
22 Jul 78	360	IN	339.3
ANTENNA TYPE	ANTENNA NUMBER	POWER IN WATTS	LOCATION
AT-197	E-1	10	RX-SITE

TAB: F-3-4

RADIATION PATTERN (-97.5 dBm REFERENCE)



DATE	RADIAL	IN/OUT	FREQUENCY
22 Jul 78	180	OUT	339.3
ANTENNA TYPE	ANTENNA NUMBER	POWER IN WATTS	LOCATION
AT-197	E-1	10	RX-SITE

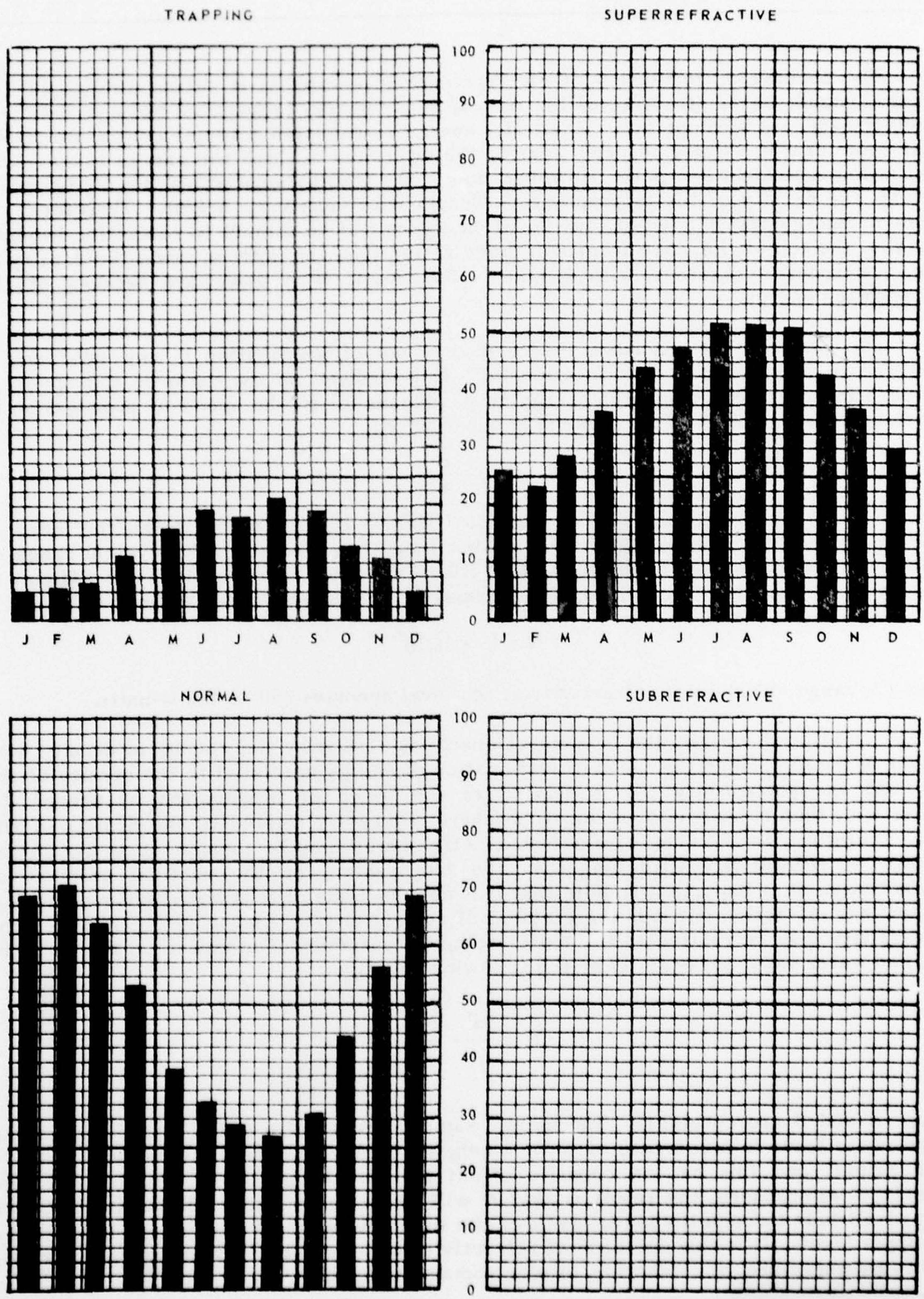


DATE	RADIAL	IN/OUT	FREQUENCY
22 Jul 78	360	OUT	339.3
ANTENNA TYPE	ANTENNA NUMBER	POWER IN WATTS	LOCATION
AT-197	E-1	10	RX-SITE

FREQUENCY OF REFRACTIVE CONDITIONS IN PERCENT

NAME OF BASE

McConnell AFB, KS



TITLE

REFRACTIVE THEORY AND DEFINITIONS

1. The bending or refraction of electromagnetic energy as it passes through the air occurs because of the structure of the troposphere. Energy propagated through a vacuum would travel in a straight line. Similarly, energy transmitted through any gas (or liquid) that is uniform in density perpendicular to the direction in which the energy is traveling, will follow a straight line path. However, due to the physical characteristics of the troposphere, the density of the troposphere decreases with increasing height. Therefore, the front of energy transmitted at low elevation angles will be subject to refractive bending. Usually, the top of the wave front will move faster than the bottom, since the density of the atmosphere decreases with height. The result is a downward bending of the transmitted energy.

2. The number that describes the relative speed of propagation in any substance is referred to as the index of refraction (n). It is defined as the ratio of the speed of propagation of electromagnetic energy in a vacuum (c) to the speed of propagation of electromagnetic energy in the medium in question (v):

$$n = \frac{c}{v}$$

Within the wavelength band from 1 cm (30 GHz) to 10 meters (30 MHz), the index of refraction does not change appreciably as the frequency changes. The typical range of values of n at sea level is from 1.000250 to 1.000450. Since these numbers are difficult to work with, a "scaled-up" quantity called refractivity (N) is used, and is defined as

$$N = (n - 1)\,10^6$$

Thus the range of values of refractivity at sea level becomes 250 to 450 N-units.

3. As mentioned earlier, the bending of energy is caused by the change in density with height in the air. Since the speed of propagation of energy is related to the density of the air, and the refractivity (N) is related to the speed of propagation of energy (by definition), then refractivity in the troposphere is directly related to the density of the air. Therefore, the bending of electromagnetic energy may be thought of as due to the change of refractivity with height in the troposphere, or the vertical gradient of refractivity. It is important to note that it is not the value of N at a particular point that determines refraction but it is the gradient of refractivity that must be considered. The refractivity may be related to the meterorological variables of pressure (p), temperature (T), and water vapor pressure (e) by the following equation:

$$N = \frac{Ap}{T} + \frac{Be}{T^2}$$

where A and B are constants. The normal rapid decrease of p and e with height in the troposphere leads to a decrease of N with height. Temperature usually decreases slowly with height, and this has an opposite effect on the change of N. In the so-called "standard" atmosphere, the result is that N will decrease by about 12 N-units per 1000 feet of altitude through the lower levels of the troposphere, and 6 N-units per 1000 feet in the upper levels. It is this decrease of refractivity with height that leads to the "normal" downward curvature, or refraction, of electromagnetic energy.

TITLE

REFRACTIVE THEORY AND DEFINITIONS

4. In the "real" troposphere all is not so simple. The temperature and water vapor pressure may vary in any manner, while atmospheric pressure will continue to decrease with height. This seemingly random variation of the meteorological terms will lead to unusual changes in refractivity with height. Refractivity may decrease more than in the "standard" troposphere, causing more pronounced bending of electromagnetic energy. On the other hand, refractivity may actually increase with height, which may result in an upward curvature of a radio/radar beam (opposite the curvature of the earth). The propagation of electromagnetic energy along a path that is different from the usual or expected path is known as "anomalous propagation" (AP). The refraction that results under various AP conditions is referred to as either subrefraction, superrefraction, or trapping (ducting). These refractive conditions, the effects on electromagnetic energy presented as a single ray, and the gradients of refractivity that may cause them are defined below:

a. Subrefraction: Ray curvature is upward. Radio/radar ranges are significantly reduced. The occurrence is quite rare. The gradient of refractivity is equal to or greater than 0 N-units/1000 feet (average "standard" value is - 12 N-units/1000 feet).

b. Normal refraction: Ray curvature is downward but not as much as the curvature of the earth. Radio/radar performance is generally undisturbed, and the occurrence is frequent. The gradient of refractivity is less than 0 N-units/1000 feet and greater than - 24 N-units/1000 feet.

c. Superrefraction: Ray curvature is downward, more sharply than normal, but not as much as the curvature of the earth's surface. Radio/radar ranges may be significantly extended; the occurrence is frequent. The gradient of refractivity is greater than -48 N-units/1000 feet and less than or equal to -24 N-units/1000 feet.

d. Trapping: Extreme superrefraction, with downward curvature equal to or greater than the curvature of the earth's surface. Radio/radar performance is greatly disturbed, ranges are greatly extended, holes in coverage may appear; occurrence is not normally frequent. The gradient of refractivity is less than or equal to -48 N-units/1000 feet.

5. For an understanding of refractive effects on the system being evaluated, refer to AFCS Pamphlet 100-79.